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PULMONARY TUBERCULOSIS

AND ITS COMPLICATIONS

WITH SPECIAL REFERENCE TO DIAGNOSIS AND TREATMENT FOR GENERAL PRACTITIONERS AND STUDENTS

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TO

THE MEMORY OF MY FATHER

Calvin F. Bonney, M. D.

WHO FOR NEARLY HALF A CENTURY SUSTAINED

THE HIGH IDEALS OF THE GENERAL PRACTITIONER

PREFACE

It is quite impossible to present an exhaustive treatise upon all phases of pulmonary tuberculosis, and in submitting this volume for the criticism of reviewers, I have no apology to make for its limitations and imperfections. All physicians who have had a large experience in the management of pulmonary invalids are forced to the conclusion that there is not so comprehensive a knowledge of the disease as fully to conserve the interests of society. Despite the many excellent contributions upon the general subject, there is perhaps a justification for publishing the following pages, which embody largely the results of personal experience. This book is not designed for the benefit of skilled specialists in the treatment of pulmonary affections, but for the use of general practitioners whose opportunities for clinical study may have been somewhat limited. Its preparation, conducted during the course of an active practice, has consumed a vast amount of time, and the work has been delayed by many unavoidable interruptions.

It has been my desire that the book should be devoted essentially to the clinical aspects of pulmonary tuberculosis, and an effort has, therefore, been made to emphasize practical considerations. To this end I have endeavored, through the various lights and shadows of every-day observation, to portray different phases of the disease in such a manner as to accentuate important points without obscuring other detail. In the interests of clearness and force, brief illustrative cases are introduced in the text, but comparatively little space is devoted to the consideration of alluring theories. In presenting certain aspects of pulmonary tuberculosis it has been necessary to make use of the contributions of innumerable scientific workers. To those whose labors in the realm of experimental research, histologic study, or clinical observation have added to the sum-total of our present knowledge, I have endeavored to give due credit in the text. If suitable recognition has not been accorded in any instance, such omission is purely unintentional. In several paragraphs relative to the physiologic effects of climate, I have made free use of material contained in Huggard's "Handbook Upon Climatic Treatment," and wish to express my obligation.

It is with some hesitation that I venture, in the last chapter of the book, to report my clinical observations concerning the practical application of vaccine therapy to cases of pulmonary tuberculosis. Some doubts have existed in my mind as to the propriety of introducing more than passing mention of this phase of specific medication. It is apparent that such a subject, even though of engrossing interest and probable value, must be adjudged upon the basis of continuous conservative investigation. While it is recognized that errors inevitably occur in the interpretation of clinical findings, such a study relative to the actual efficiency of newer therapeutic measures must remain an important feature of scientific progress. The evolution of complete

knowledge concerning the workings of the complex mechanism of immunity will be acquired only through the process of years. It may appear, therefore, somewhat presumptuous at this time to present clinical observations with reference to a feature of treatment that may be subject to considerable future modification. In view, however, of an instructive experience during the past one and one-half years with the bacterial vaccines, I am constrained to report the results thus far attained.

Appreciative thanks are rendered to many private patients who have granted photographic illustrations. Grateful acknowledgment is made to Dr. William C. Mitchell, for valuable suggestions with reference to features of bacteriologic interest; to Dr. J. A. Wilder, for reviewing the chapters upon Pathology; to Dr. Howell T. Pershing, for reading the text upon Miliary Tuberculosis, as well as upon the Symptoms and Course; to Dr. Charles A. Powers, Dr. F. L. Dixon, and Dr. George B. Packard, for reviewing portions of the book devoted to Surgical Complications; to Dr. Robert Levy, for reading the text upon Tuberculosis of the Larynx and assistance rendered in securing photographs of this condition; to Dr. J. N. Foster, for reviewing the chapter upon Tuberculosis of the Ear and Nose; to Dr. H. B. Whitney, for reading the text relating to the Physical Signs; to my assistant, Dr. E. W. Emery, for very useful suggestions in connection with many portions of the book, and to Dr. S. B. Childs, for valuable aid in securing the *x*-ray pictures. I am indebted to Mr. Ira D. Cassidy for the skill displayed in the drawings and paintings, to Mr. F. O. Stanley and Mr. B. S. Hopkins for their interest and efficiency in connection with the photographic illustrations, to my publishers for the excellence of the reproductions, and to my secretary, Miss Nellie Bryant, for aid in the preparation of the manuscript.

S. G. Bonney.

Denver, Colorado,
July, 1908.

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PULMONARY TUBERCULOSIS

PART I

ETIOLOGY AND PATHOLOGIC ANATOMY

SECTION I

General Etiologic Considerations

CHAPTER I

INTRODUCTION

In a work devoted essentially to the clinical aspects of pulmonary tuberculosis it is manifestly impossible to dwell at length upon features of a purely bacteriologic nature, although they constitute data of enormous interest in connection with the general subject of tuberculosis. A vast amount of scientific work has been performed by enthusiastic students during the quarter century since the discovery of the tubercle bacillus by Robert Koch. The results of their labors have been of tremendous value from the standpoint of scientific investigation, and of vital importance in the elucidation of practical problems pertaining to the etiology of this disease. Their patient toil in the realm of animal experimentation and of laboratory research has been productive of such a mass of absorbing medical literature as to preclude more than its cursory mention even were this book limited solely to a historic review of the progress achieved along these lines. Much less, then, is detailed reference permitted to the innumerable contributions of the many workers in the field of scientific study, the sum-total of whose observations is of such infinite magnitude. A volume of enormous proportions is needed to accord justice and honor to the noble work of the earlier students.

It would, indeed, be a Herculean task for one not especially trained in the technic of laboratory methods nor fully conversant with the intricate details and scope of previous investigation to attempt in review an elaborate exposition of the achievements of individual students during the slow evolution of our present knowledge concerning the etiology of tuberculosis. There is disclaimed any original scientific study or profound knowledge of the special departments relating to bacteriologic or histologic research. There will be no attempt to introduce contributions of this nature nor to advance unsustained personal opinions concerning the proper interpretation to be placed upon the reported results of exper-

imental work by others. In such purely technical matters it is hoped to voice, as far as possible, the consensus judgment of those who are qualified by experience and equipment to form rational conclusions. Elaborate scientific treatises abound which present in detail the results of individual observations concerning the tubercle bacillus and the many aspects of infection. The large and comprehensive volume by Straus upon the bacillus alone is an example of the stupendous amount of literature extant in relation to features of etiologic interest. An effort will be made in this connection merely to review the more practical and essential etiologic facts without undue consideration of the various theories as yet incapable of complete verification.

HISTORIC REVIEW

Tuberculosis is, beyond question, the most important disease with which the human race has ever been obliged to contend. Its antiquity dates from the earliest records accessible to man. The writings of Hippocrates, 460 to 377 B. C., contain a description of the disease so correct in its essential details as to equal a work of modern excellence. From the period of Galen, 200 B. C., until the present time widely divergent conceptions have been entertained as to the pathology of consumption, but a uniform opinion has prevailed relative to its clinical characteristics. Only in comparatively recent years, however, has belief in its curability become general. Recognition of nodules or tubercles in the lung was obtained about the middle of the seventeenth century. Upon beginning anatomic investigation and with the discovery of cavity formation and pus collections numerous conjectures were offered as to the pathogenesis of the disease. The first efforts toward inoculation experiments were made in the early part of the nineteenth century, and were not attended with clearly definable results. Consequently there was much speculation concerning the possible infectiousness or transmissibility of tuberculosis. Laënnec contributed much to the knowledge of the disease by establishing a more definite relation between tubercles and consumption, and by advocating the identity of pulmonary and glandular tuberculosis from a pathologic standpoint, although the specific microörganism, of course, was unknown. Rokitansky was an exponent of the same doctrine, but insisted upon the significance of a certain adaptability or susceptibility to consumption, as evinced by a peculiar type, or "phthisical habitus." Virchow cleared the atmosphere to some extent by expounding the pathologic and histologic structure of tubercle. Microscopic research had been undertaken previously by Lebert, who described the so-called "tubercle corpuscle" as a non-nucleated cell in the midst of tubercle formation. The first experimental evidence of the inoculation transmission of the disease was furnished by Klencke in 1843. He inoculated rabbits with tuberculous material, and at autopsy, twenty-six weeks later, found disseminated tubercle deposit in the liver and lungs. In 1857 Buhl promulgated the doctrine of the origin of miliary tuberculosis as a result of the distribution, through the medium of the circulation, of an agent derived from an area of infection within the body. Villemin in 1865 conducted a series of inoculation experiments of the greatest value. In addition to introducing into animals an infective material obtained from tuberculous tissues and the sputum of consumptives, he injected into a second class non-tuberculous

pus, and in a third, the caseous matter from tuberculous cows. A tuberculous deposit was found after the introduction of purely infective matter from any source, confirming the theory of the specific infectious nature of the disease. An apparent identity of human and bovine tuberculosis also was suggested by the demonstration of tuberculous changes in all instances irrespective of the derivation of the infective agent. Despite vigorous opposition and conflicting results of animal experimentation by others, belief in the correctness of Villemin's conclusions became established upon a firm basis through the supplemental experiments of several observers. Among these, Cohnheim contributed prominently to the acceptance of Villemin's teaching by his method of inoculation into the anterior chamber of the eye of a rabbit. By this means opportunity was afforded for visual inspection of the gradual development of pathologic change. The discovery of the specific microorganism in tuberculous tissues and its etiologic relation to the development of the disease in man and lower animals was made by Robert Koch in 1882. By an original method of differential staining he succeeded in isolating the tubercle bacillus and showed its presence in infected areas in all parts of the body. Previous to this, characteristic tubercle formation had been recognized in the scrofulous affections of glands, bones, and joints, although the precise infective agent had not been discovered. Koch demonstrated the absence of tubercle bacilli in other than tuberculous conditions, and even accomplished the successful inoculation of animals from pure artificial cultures of tubercle bacilli after the elimination of all extraneous elements and the removal of accessory sources of error. Koch thus established the cause of tuberculosis among man and animals by the discovery of the bacillus and the results of inoculation experiments. The apparent etiologic identity of all forms of tuberculosis in different species was determined also upon the basis of the characteristic histologic structure of the primary tubercle. Since this time a mass of evidence has been presented by numerous observers both for and against the acceptance of essential differences in the cultural characteristics, virulence, and powers of transmission of the bacillus in the several animals in which a natural habitat is found. Despite a degree of similarity of the clinical manifestations in different species, important differences, referable to the bacillus of various types have been noted and will be the subject of future discussion. The tubercle bacillus of human origin is of more essential present interest.

CHAPTER II

THE TUBERCLE BACILLUS

In view of all that has been written of this microörganism, attention will be called merely to a few of its more important features. The tubercle bacillus is a small, immobile rod of somewhat varying size and shape. The average length has been described as from one-fourth to one-half the diameter of a red blood-corpuscle. Differences in length, however, are found to exist in accordance with the virulence of the

bacilli and the age of the culture. An evidence of attenuation is found in a greater lengthening and thinning of the microörganism, and of virulence by the presence of short, thick bacilli. A considerable variation in size is recognized in bacilli taken from the sputum, which, as a rule, are of greater length than those observed from culture growth. Differences also exist in the contour or shape of the microörganisms, in their disposition with reference to one another, and in their specific staining reaction. A notched, beaded, or clubbed appearance, with a tendency toward flexion, is suggestive of an old attenuated bacillus. A fragmentary or broken-down rod also is strongly indicative of degenerative change. On the other hand, the aggregation of bacilli in clumps, as opposed to an isolated or scattered disposition, is somewhat characteristic of active virulence. The same is true of their ability to take rapidly a deep primary stain. An essential property of the tubercle bacillus is its resistance to decolorization by acids. On account of this attribute it is easy to recognize the bacillus in the sputum after the removal of the primary stain from the cellular elements and associated bacteria. The subsequent blue contrast stain of these portions of the specimen renders the continuous red color of the bacilli especially pronounced. An important preliminary to the staining process is the selection from the midst of the tuberculous sputa of small cheesy particles often found in the more dependent portions. Tubercle bacilli are much more frequent in these caseous deposits than elsewhere in the expectoration. When the bacilli are particularly scanty, it is sometimes advisable to dilute 100 c.c. of sputum with 200 c.c. of water to which have been added about 8 drops of a 10 per cent. solution of sodium hydroxid. A homogeneous solution is obtained by boiling, and the centrifuged sediment is examined for tubercle bacilli. A thin smear of this portion of the sputum should be made either upon the cover-glass or the slide. Several methods of staining are employed, notably the procedures of Gabbet, Ehrlich, the Weigert-Ehrlich, the Ziehl-Neelsen, and the Pappenheim. The principle employed in each instance is the production of a deep, primary red stain with carbol-fuchsin and the subsequent decolorization of all portions of the specimen except the tubercle bacilli, which later are made more conspicuous by the contrast stain of the cellular elements. The carbol-fuchsin solution is composed of one part of fuchsin, 100 parts of a 5 per cent. solution of phenol, and 10 parts of absolute alcohol. The decolorization is secured by a dilute solution of sulphuric, nitric, or hydrochloric acid. The smears are allowed to dry in the air upon the cover-glass and later are fixed by being passed quickly three times through the flame of an alcohol lamp or Bunsen burner. The specimen is then ready for staining with the carbol-fuchsin solution. It was formerly the practice to immerse the cover-glass in this solution for twenty-four hours, but by the use of heat this process may be shortened to a few minutes. A convenient and rapid way of staining consists of placing a few drops of the carbol-fuchsin solution upon the cover-glass and holding this for a few minutes over the flame. The fluid should be allowed to simmer or steam, but must not be brought to the boiling-point. At the end of one minute the specimen is washed with water and decolorized by adding a few drops of 25 per cent. solution of sulphuric acid. The decolorization should be repeated once or twice until the film upon the cover-glass when held to the light appears colorless and opaque. The process is made more complete by the addition of a few drops of 98 per

cent. alcohol. After washing, the specimen is stained with methylene-blue for about thirty seconds, although no harm results, as a rule, if this is permitted to remain for a considerably longer period. After washing again with water and drying the specimen usually is mounted in Canada balsam.

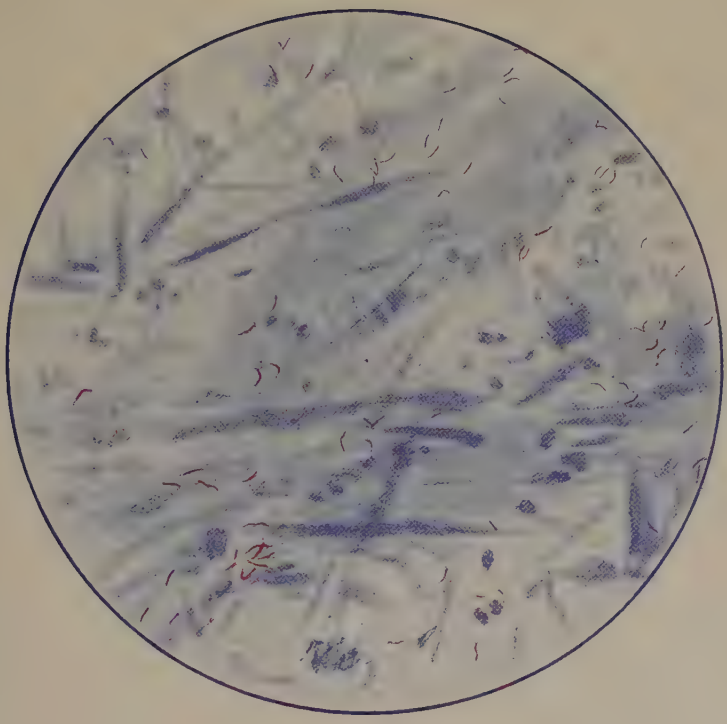
The retention of the primary stain by the microörganism is of exceeding value in the differentiation of the true from the pseudotubercle bacillus. There remain, however, a considerable number of acid-fast bacilli which closely resemble the tubercle bacillus in other respects. For this reason the appellation "pseudotubercle bacillus" is usually restricted to bacteria which simulate the appearance of tubercle bacilli and do not yield to acid decolorization. Among the varieties which do not surrender their primary stain upon the employment of acids the smegma bacillus is the most important, as the presence of this microorganism may lead to unfortunate errors of diagnosis involving to a vast degree the well-being of the patient. In cases susceptible of reasonable doubt a staining in accordance with the ordinary methods must lead to inevitable confusion in the interpretation of results. It is found that the smegma bacillus holds its color after a prolonged exposure to absolute alcohol, but yields its stain upon boiling in alcohol. Aronson has shown that the tubercle bacillus contains wax and fatty acids, on account of which combination the microörganism is acid fast. The smegma bacillus, on the other hand, has fat and sebaceous matter in place of wax. This bacillus may be robbed of its fat by boiling in alcohol, which has slight effect upon the wax contained in the tubercle bacillus. Bienstock and Gottstein were able to treat other bacilli with fats, as butter, lanolin, paraffin, and wax, and make them acid fast. By the addition of these substances to several culture-media they were able also to give a degree of acid-fastness to bacilli which otherwise yielded to acid decolorization. Various procedures are employed for the differential staining of the true and the smegma bacillus, all based upon the application of the influence of alcohol. The use of inorganic acids is found of no value. Pappenheim has devised a method which produces a ready decolorization of the smegma bacillus by fluorescein-alcohol. After the production of the primary stain the preparations are immersed several times in Pappenheim's solution, which consists of one part of corallin in 100 parts of absolute alcohol, to which methylene-blue is added to saturation and diluted with 20 parts of glycerin (Simon). As a practical matter, error in the differentiation of the bacilli may take place principally in connection with genito-urinary tuberculosis. It is now the custom of clinicians and surgeons to insist upon catheterized specimens of urine before submission to bacteriologists for examination. This plan obviates to a degree the danger of confusing the tubercle bacillus with the smegma microörganism.

The lepra bacillus is of but slight interest to practitioners in this country. It presents, however, several points of resemblance to the tubercle bacillus, particularly in form and staining reaction. Cornet has referred to the disposition of the lepra bacilli, as pointed out by Bâbes, this feature distinguishing them from the tubercle bacillus. The former are found by preference within the cell and grouped very closely together. The latter are usually without the cells, but if intracellular, do not arrange themselves in such dense masses as to obscure the nucleus. He also calls attention to the comparative rapidity with which the lepra

bacillus takes the primary stain and its ability to do this even without the exhibition of heat, a quality not possessed by the tubercle bacillus. According to James, there are now thirty microörganisms more or less resembling the tubercle bacillus in form, and almost equally resistant to acids. A close analogy has been suggested between these varieties and the tubercle bacillus, the essential difference pertaining to evolutionary changes of adaptability in accordance with a varying environment. These microörganisms are not found, as a rule, within the body, though occasionally they do occur in the sputum, feces, or secretions from nose and pharynx and within the tonsillar crypts. They are distributed, to some extent, in the vegetable kingdom and in the excrement and secretions of animals accustomed to herbivorous diet. The most important of these microörganisms is the timothy-grass bacillus. Others have been found in milk, butter, manure, and earth subjected to fertilization. The grass bacillus, unlike the other varieties mentioned, will grow at the same temperature as the tubercle bacillus, and is thought to be equally resistant to external influences. Its discoverer, Moeller, claims to have been able to produce the same lesions with this agent as with the tubercle bacillus, but finds cultural differences and a much diminished virulence.

The **cultural characteristics** of true tubercle bacilli consist of their very slow growth and the necessary maintenance of a high temperature, approximating that of the blood. Cultures may be obtained from tuberculous tissue and infected sputum. The usual method is to inoculate a small portion of the sputum or infective material into a healthy guinea-pig. After about three weeks the animal is killed, and, under strict aseptic precautions, the tubercles are dissected from the tissues and transplanted into culture-media. Colonies may also be produced by the direct implantation of tuberculous material into the various culture-media; this method, however, being quite difficult. This is done by thorough rubbing of the surface of the media with an infected platinum loop. The medium may be solid or liquid, and consist of blood-serum, bouillon, glycerin-agar, or glycerin bouillon. After a period of two or three weeks in the incubator at a temperature of 37° C., there is found upon the surface of the culture-medium a growth resembling an irregular cauliflower excrescence, yellowish white in color, and of a peculiarly dry or crumbly appearance. When cultivated in bouillon, a small scale from a solid culture-medium is transplanted to the liquid in such a manner that it floats upon the surface. By means of Hesse's *Nährboden* spread in Petri dishes the time may be shortened from ten days, which was required by the older methods, to four or five days, the fresh sputum being deposited upon the medium by drawing a portion of the slimy pus over its surface. Successive transplantation to new media results in more profuse vegetation and a more luxuriant flora. Some observers attribute a diminished virulence to cultures of rapid and luxuriant growth, and an increased pathogenic power to those difficult of cultivation and of scant growth. This is the opinion of Lartigau, as the result of experimental inoculation. The cultural vitality also of the tubercle bacillus is supposed to diminish with the rapidity of growth. Temperature greatly in excess of that of the blood is extremely detrimental to its vital resistance. Its growth is destroyed at 42° C., and the bacillus quickly becomes extinct at 70° C. A distinctly inhibitory influence upon its development is ascribed to sunlight, especially if

PLATE I.



Tubercle bacilli from specimen of sputum. Bacilli red, other organisms and tissues blue. The so-called attenuated variety of tubercle bacilli. Note the elongated rods, some of which are notched and beaded. Note also faintness and irregularity of stain.

the microörganism is exposed to the direct rays. It is much more resistant to cold, however, and is claimed by some to retain its vitality after freezing. The period of retention by bacilli of their pathogenic virulence under various external conditions has been the subject of much experimental observation. While the testimony of several workers in this field of research, which is possessed of so much practical interest, is somewhat conflicting, there seems to be, on the whole, a fairly uniform belief in the approximate duration of its vitality under similar conditions. In 1869 Villemin determined the retention of virulence in sputum after several weeks. Schill and Fischer found that bacilli contained in dry sputum preserved their vitality for six months, but rarely longer. Other observers have found the vitality to vary within wide limits under differing conditions. Some report a loss of virulence after two or three months at most, and others not until after nine months. Cornet assumes that, under ordinary circumstances, the vitality is destroyed in about three months, and that a retention of pathogenic power for a period of six months is exceedingly rare and occasioned only by the existence of extraordinary conditions. It is evident that the lack of uniformity of results is attributable to essential differences in the conditions to which the sputum is subjected, viz., the thickness of the layer, the exposure to the sun or to diffused sunlight, and the degree of moisture and wind as determined by seasonable changes. In this connection it is reasonable to assume that if destruction of growth and vitality ensues as a direct result of fundamental attributes of weather, including sunshine, degree of moisture, air movement, etc., important differences inevitably must accompany the climatic conditions under which the experiments are conducted. In other words, if sunshine and dryness are essential factors to overcome the vitality of the bacilli, widely varying results should be reported during seasons when rains do not prevail and in localities where sunshine is almost continuous. To this end the experiments of Gardiner, of Colorado Springs, at an altitude of 6000 feet, are of considerable interest. Gardiner exposed to the direct rays of the sun, sputum from a tuberculous patient containing bacilli of established virulence. The sputum remained for varying periods upon sandstone and wood. It was found that a hard, superficial crust formed in the process of drying, and that it was impossible to detach even minute quantities from this surface with the blow-pipe. Actual grinding of the crust was required in order to produce distribution of the bacilli. After one and three-quarter hours of exposure the sputum was rubbed up with sterilized water and inoculated into guinea-pigs, with positive results in one case. It is noteworthy, however, that the portion selected for inoculation was taken from a mass of over two drams of unsmeared sputum, the upper surface of which had hardened into an impermeable crust.

Ransome and Delephine had previously conducted an elaborate series of experiments which showed the preponderating influence of direct sunshine as a destroyer of bacillary activity. Sputum exposed to light (not direct sun's rays) and air for forty-five days did not produce tuberculosis after inoculation of rabbits. An exposure to air without sunlight during the same period was insufficient to destroy the power of transmitting the disease. Guinea-pigs were found to respond positively to sputum exposed to air in dark places, but negatively if the sputum had been subjected to diffused light as well as air

for an equal length of time. It was found that an exposure to light for three days and one hour was sufficient to render the bacilli inert. The inference was gained from these observations that sunshine was the all-important factor for the destruction of the pathogenic virulence of the bacilli. To what extent moisture or dryness entered into the elucidation of the problem was not determined at that time. Migneco found that the bacilli in dried sputum were not killed until from twenty to thirty hours' exposure to sunlight in Italy. In 1899 Mitchell and Crouch, of Denver, after an elaborate investigation, found dried sputum to be quite virulent up to twenty hours' exposure in direct sunlight, after which the virulence became attenuated and was lost in about thirty-five hours' exposure. Recent observations by Twitchell have been conducted most carefully and furnish desirable information concerning the influence of dryness and temperature as well as sunlight. Direct sunshine was found capable of rendering bacilli inert after a few hours, which result is much in accord with that of Koch, who, in 1890, asserted that destruction ensued in from a few minutes to several hours. Straus found bouillon cultures were killed in two hours. Twitchell's technic was evolved so perfectly and the conclusions are so incontrovertible that a brief abstract of his methods and results is appended:

One c.c. of virulent sputum from two patients with active tuberculosis was deposited in sterilized, corked, and paraffined white glass bottles, 3 c.c. in diameter, with a depth of 1 c.c. One bottle was placed in a dark, moist box, and similar bottles in a dark closet, and in the diffused light of an ordinary room. In another series of experiments the bottles were exposed to like conditions, but were stoppered with cotton. Still again the sputum was deposited in sand within the bottles, with the bottles corked and paraffined in some instances and unsealed in others. Sputum deposited in sterilized white glass bottles with and without sand, sealed and unsealed, were placed in the thermostat. Open white glass bottles of sputum were deposited in the open air during the winter months. Corked and paraffined bottles were buried in the ground. Other bottles corked and paraffined were packed in ice or frozen in blocks of ice. Sputum was deposited upon handkerchiefs, carpets, wood, and woolen blankets under ordinary room conditions. Subsequent inoculation experiments with the sputum placed in sand and in blocks of ice were not satisfactory. The sputa placed in a dark moist box or a dark closet, under the varying conditions described, produced tuberculous lesions in guinea-pigs after one hundred and fifty-seven days, but in no instance after one hundred and eighty-eight days. Positive results attended the inoculation of guinea-pigs with sputum contained in paraffined bottles after exposure to the diffused light of an ordinary room for one hundred and twenty-four days, but not after one hundred and seventy-five days. The sputum in open bottles placed out-of-doors in the winter months produced tuberculous lesions after one hundred and ten days, but not after one hundred and thirty-two days; the sputum from ice after one hundred and two days, but not after one hundred and fifty-three; from a handkerchief or woolen blanket after seventy days, but not after one hundred and ten. The same was true of the sputum deposited upon wood. Tuberculous lesions were produced by the inoculation of sputum deposited upon the carpet after thirty-nine days, but not after seventy; upon the sand in a light, dry place after thirty days, but not after

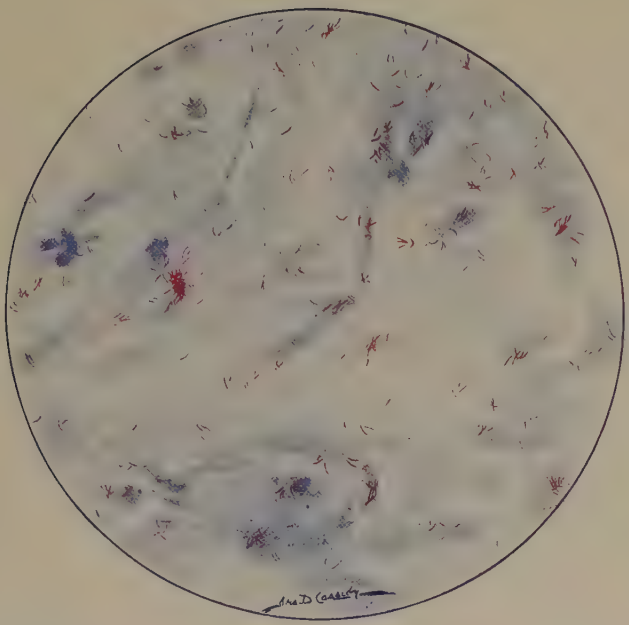


Fig. 1.—Tubercle bacilli from specimen of sputum—the so-called virulent type. Note the short, bright-staining rods, also presence of clumps. Note, further, broken-down appearance of cells and tissue. This is from patient having very large cavity. See radiograph, Fig. 72, p. 276.

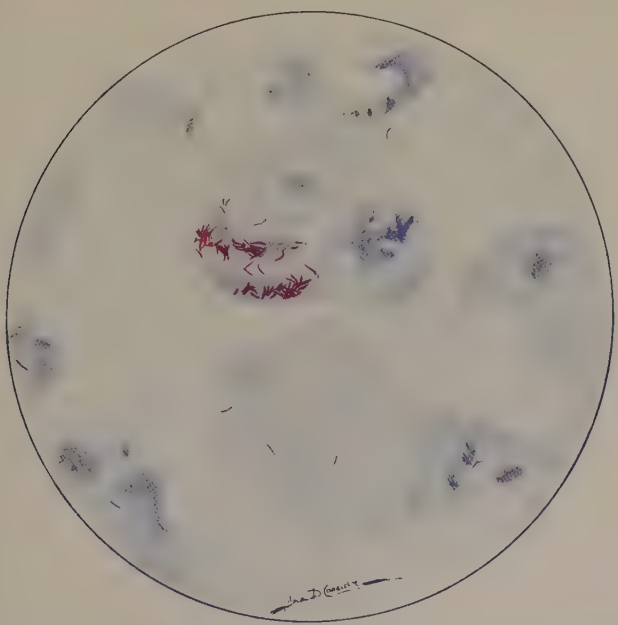


Fig. 2.—Bacilli—undoubtedly smegma—from centrifuged specimen of urine; decolorized by alcohol; same case as preceding.

seventy. The sputum exposed to the direct rays of the sun was found productive of a tuberculous lesion after one hour, but not after seven hours.

Culture growth of the tubercle bacillus has been known for years to be inhibited by the introduction into the media of a variety of substances in certain proportions. Chief among these are creasote and iodoform. The practical application of their action upon tubercle bacilli has been attempted by means of inhalations of the former, local injections of the latter, and internal administration of each. Although favorable results have been reported from time to time, their use in general has been disappointing and sometimes injurious. The human body, on account of innumerable complicating conditions and processes, is not to be adjudged a culture-medium upon the basis of which internal therapeusis is to be determined. The life of the bacillus external to the body is found to be destroyed by the action of numerous chemicals and by prolonged boiling. Corrosive sublimate, so freely employed for the disinfection of sputum, is, as a matter of fact, of little value on account of the protective coating of the bacillus by the coagulation of the albuminous matter. Twenty-four hours is required for the destruction of the vitality of the bacilli by a 5 per cent. solution of phenol. The presence of various bacteria in culture experiments or in decomposing sputum is inimical to the growth of tubercle bacilli. This is due to the comparatively rapid growth and development of other microörganisms.

The **chemic composition** of the tubercle bacillus has been the subject of careful investigation, which has been reported by Hammerschlag, Behring, Hoffmann, de Schweinitz, Aronson, Ruppel, Levene, Baldwin, and Trudeau. It is evident, as a result of their research, that the fatty or waxy constituent is of considerable importance and obtains in much larger proportion than is the case with other bacteria. This has been found to be the only portion of the bacillus to retain the stain after the exhibition of the acid, all the other component parts surrendering the color immediately. Baldwin has shown that the fat, however, is not an element of material significance in the production of toxemia, as the tuberculin reaction was present in animals previously inoculated with fat-free bacilli. While the fat may be assumed to form an average of 30 per cent. of the substance of the bacillus, a considerable variation has been found in the relative proportions by different observers. These fluctuations have been ascribed to the employment of various media and to the differences of method in estimating the amount of fat. Both Trudeau and Baldwin have reported separately the results of Levene's work in connection with the nucleoproteids. Three distinct forms of these substances were recognized, all containing phosphorus. Nucleic acid was found by Levene and Ruppel after treating the watery extract of pulverized tubercle bacilli with acetic acid and analyzing the resulting filtrate. The toxic properties of the bacillus are referable to this derivative. Levene and others have demonstrated also the presence of carbohydrates.

VARIOUS TYPES OF TUBERCLE BACILLI

It has been shown that numerous microörganisms closely resemble the tubercle bacillus in form, size, and staining reaction, but exhibit differences in cultural characteristics, especially with reference to less-

ened resistance and greater susceptibility to temperature conditions. In addition to the variations of virulence and growth among tubercle bacilli it has been found that other differences exist according to their habitat.

Theobald Smith has called attention to what he terms "the complex relationship established in time by a selective adaptation between two living organisms, of which one is the parasite of the other." He emphasizes the interdependence of both organisms, and ascribes a disturbed equilibrium between the two as a sufficient cause for important changes in the bacillus as well as in the host. These differences in the cultural attributes of the bacilli, their virulence, and the character of resulting pathogenic processes are capable of explanation upon the basis of fundamental changes in the species, in which the bacillus is permitted to abide with a forced adaptation to the environment.

Irrespective of these broadly conceived hypotheses, which are worthy of the utmost consideration, it is true that essential differences are recognized between several distinct types of tubercle bacilli, *i. e.*, those of human origin, the bovine, the avian, and the bacilli of fish or other cold-blooded animals. The human and bovine forms are described as mammalian bacilli, which, with the avian, have certain characteristics in contradistinction to the bacilli found among fish. The latter bacillus is unable to survive at the temperature of the human body, and, therefore, is incapable of transmitting tuberculosis to man or animals. Among the three varieties of bacilli sometimes found in warm-blooded animals, the avian presents important features of dissimilarity in comparison with the human and bovine forms. Rivolta, Maffucci, Ribbert, Straus, and Koch have pursued investigations concerning the relation of this to the other types of tubercle bacilli. The avian bacillus was found to withstand a greater degree of heat than the human or bovine, its growth not being inhibited until after the temperature was elevated nearly two degrees higher than was required for other forms of tubercle bacilli. Birds upon inoculation with human bacilli were found to exhibit but slight local reaction, without evidence of constitutional change. Nocard showed that mammalian bacilli grown in sacs of collodion within the peritoneal cavity of chickens could be modified to such an extent as to produce tuberculosis in fowl. On the other hand, Courmont and Dor demonstrated that when the avian bacillus was grown at lower temperatures and passed through rabbits it became endowed with pathogenic property for mammalia. Roemer reported that an interesting epizoötic among chickens resulted from eating the entrails of a tuberculous cow. Shattock, Seligman, Dudgeon, and Panton, in a recent study of the relationship between avian and human tubercle bacilli, conclude that the human variety is but slightly pathogenic to the pigeon, and when introduced with food into the digestive canal, induces no local lesions of the intestine or abdominal viscera. They report that but slight local or glandular processes are produced by the injection of human bacilli into the muscles or subcutaneous tissues. Curiously conflicting results were obtained from inoculation of the rabbit and guinea-pig with avian bacilli, the former quickly yielding to general infection and the latter exhibiting but slight susceptibility. These results are all the more remarkable in view of the relatively greater resistance of the rabbit than the guinea-pig to human bacilli. Flexner has called attention to the fact that, in spite of the susceptibility of the rabbit to the avian

bacillus, the pathologic processes are radically different from those appearing as a result of infection with mammalian bacilli. He cites the absence of tubercles and caseation in the presence of an enlarged spleen. The avian, although occasionally present in lower animals, have never been discovered in man.

CHAPTER III

THE RELATION OF HUMAN AND BOVINE BACILLI

The relation of human and bovine tuberculosis for several years has engaged the attention of the best observers. Koch, upon announcing the discovery of the tubercle bacillus in 1882, promulgated the dictum that human and bovine tuberculosis were identical, and that the bovine type was directly transmissible to man. Virchow had stated in 1863 that the two diseases were entirely distinct. This view, however, after the assertion of Koch, was not accepted by the profession in spite of the fact that Chauveau, Günther, Harms, and Bollinger, after feeding calves, swine, and goats with human tuberculous material, had failed to produce tuberculosis, although these animals quickly succumbed if the food contained milk and pieces of lung from tuberculous cattle. In 1893 Baumgarten questioned the complete identity of the two diseases and cited the previous failures to effect a transmission of tuberculosis to cattle through the medium of human bacilli. He also reported work done by Gaiser under his direction to substantiate the correctness of his view. A calf inoculated with human bacilli exhibited no evidence of disease, and when killed after several months showed no trace of tuberculous change. Another subjected to inoculation with bovine bacilli in the anterior chamber of the eye and in the flank, displayed a typical tuberculous process of the eye, and after much emaciation died in six weeks, showing at autopsy general miliary tuberculosis. In 1898 Smith, in this country, obtained negative results from the inoculation of cattle with human bacilli. Similar experiments were recorded by Frothingham and Dinwiddie in the following year. Their conclusions, however, were not to the effect that human tuberculosis was incapable of transmission to cattle, but merely that the bovine bacillus possessed a higher pathogenic power for these animals than the bacilli of human origin, to which the cattle were believed to be more or less resistant. Theobold Smith had expressed doubt as to the absolute identity of the two diseases, but did not advance the theory of impossibility of transmission. Koch, however, in 1901 openly disavowed his previous conclusions and maintained that human tuberculosis differed from bovine and could not be transmitted to cattle. He also assumed that infection from the bovine bacillus rarely, if ever, took place in man.

In substantiation of the first proposition he placed upon record the results of experiments conducted during the preceding two years by Schütz and himself. Nineteen young cattle free from tuberculosis were subjected to prolonged periods of inhalation exposure, to food infection, and to direct inoculation by human bacilli. These animals, after six to eight months, presented no trace of tuberculous lesion at autopsy. The

same attempts with bovine bacilli were attended with constitutional symptoms within one week, and extensive tuberculous changes were found at autopsy two or three months later. Similar experiments with human and bovine bacilli yielded like results in swine, asses, sheep, and goats. In support of his second proposition he pointed to the large number of bovine bacilli contained in butter and milk and to the alleged rarity of primary intestinal tuberculosis in infants. He cited statistical observations concerning the infrequency of this condition, although little children especially were recognized to be exposed and predisposed to infection. But ten cases were observed during a period of five years in the Charité Hospital in Berlin. Baginsky was reported as never having observed, out of 933 cases, an instance of intestinal tuberculosis without simultaneous involvement of lungs and glands. Biedert was quoted as having seen but sixteen cases out of a total of 3104 autopsies upon tuberculous children. Baumgarten, a few months after Koch's address, indorsed the position assumed with reference to the non-transmissibility of the two diseases, and made, as he stated, an important contribution to the subject by recalling the experiments of Rokitansky. The latter, firm in the belief of the unity of human and bovine tuberculosis, had inoculated with bacilli from cattle a number of patients suffering from incurable malignant diseases. This was done in the hope of establishing an antagonism between the tubercle bacilli and the bacteria of previous infection, thus affording a cure to otherwise hopeless invalids. Large numbers of tubercle bacilli of bovine origin were injected without noticeable results other than small localized abscesses at the points of inoculation. The autopsies upon these patients were performed by Baumgarten, and in spite of critical macroscopic and microscopic examination of the tissues and glandular structures, no evidence of tuberculous infection was discovered. While thus espousing Koch's teaching on account of the failure of inoculation experiments both upon man and animals, and while denying any especial danger to man from the consumption of bovine products, Baumgarten insisted, however, upon certain strong points of resemblance between the two diseases. He referred to the histologic identity of the tuberculous lesions in man and cattle as established by Schüppel, and pointed to the similar degenerative changes in the two conditions. He cited the production of acute miliary tuberculosis in cattle after infection with bovine tuberculosis, precisely as in man with the human bacillus. He further called attention to the same reaction in cattle as in man following the injection of tuberculin derived from human bacilli. These various facts, supplemented by a supposed morphologic and cultural identity of the two bacilli, were deemed sufficient by Baumgarten to establish a close similarity of human and bovine tuberculosis, notwithstanding the disparity shown by inoculation experiments.

Virchow, in an address delivered before the Medical Society of Berlin in July, 1901, one or two days following Koch's communication in London, referred to his previous statements in 1863 regarding the non-unity of human and bovine tuberculosis. He said: "I was not surprised to hear that Professor Koch had finally convinced himself that they were two different things, even after my old thesis containing the same statement has been regarded by the Koch school for a considerable length of time with a certain contempt, and I have borne their judgment with patience. I certainly have never understood how any

one could maintain that the two were identical." He further emphasized the existence of true pathologic tubercle as a *sine qua non* for genuine tuberculosis, insisting that the bovine infection was an example of bacteriologic disease rather than of typical pathologic tissue change. Virchow did not refrain, however, from disparaging Koch's contention concerning the rarity of primary intestinal tuberculosis. He called attention to the existence of unusual intestinal and peritoneal lesions observed at the Charité, exhibiting growths peculiar to the so-called "perle disease" of cattle, but scarcely attributable to human bacilli.

In view of these somewhat contradictory statements from many preëminent European authorities, based upon the results of careful study and experimentation, a renewed impetus was given to a study of the subject. Commissions were appointed in Germany and Great Britain to investigate this matter, and a vast amount of exhaustive research was conducted in the United States. The German authors, as a rule, were inclined to support Koch's views, although several dissenting opinions were expressed, notably those of Behring and Dungern. Weber recently has reported observations of interest and value made by the Berlin Board of Health. The bovine bacillus was found fifteen times in the cervical glands of children. He asserts that this variety occurs almost exclusively in the young, and that a marked tendency toward spontaneous cure is noted. In almost all instances reported the children were under seven years of age. He has been able to discover no instance of transmission of the bovine infection from one human being to another, and is constrained to believe that the danger of infection to man from bovine tuberculosis is insignificant as compared with that from the human variety.

Raw, although recently announcing his conviction as to the dissimilarity of human and bovine bacilli, yet attributes a large amount of tuberculosis in children to the introduction of the latter. He calls attention to the conspicuous differences between the clinical manifestations of pulmonary phthisis and other tuberculous affections, and emphasizes an apparent antagonism between pulmonary and surgical tuberculosis. He asserts that children who have suffered from strumous glands, spinal caries, tuberculous joints, and lupus are immune to phthisis pulmonalis, and, conversely, points to the infrequency of gross tuberculous lesions in cases of pulmonary tuberculosis. Upon the basis of these clinical differences, and the fact that surgical tuberculosis is essentially a disease of childhood, he concludes that the characteristic divergence of lesions is presumptive evidence of dissimilar bacilli. Relying upon clinical and autopsy observation, together with certain inferences from analogy, he submits the provisional opinion that the enlarged lymphatic glands of the neck, tuberculous peritonitis, tuberculous bones and joints, tuberculous meningitis, and lupus are occasioned by the ingestion of bovine bacilli, while the origin of pulmonary phthisis is attributed to the introduction of the human bacillus.

The British Commission, appointed after the close of the International Antituberculous Conference in London in 1901, was composed of the renowned Sir Michael Foster, chairman, and Professors Woodhead, Martin, Boyce, and MacFadyean. Their first report, published in 1904, expressed quite clearly a disinclination to accept the teaching of Koch as to the non-intercommunicability of human and bovine tuberculosis. Numerous experiments were undertaken by the commissioners

to determine primarily whether the disease in animals and man was one and the same, and whether infection could take place from one to the other. Investigations were made by a comparison of the lesions produced in cattle upon the introduction of bacilli of human and bovine origin. Similar experiments were performed upon the anthropoid ape, an animal nearly related to man, and also upon guinea-pigs, rabbits, goats, dogs, cats, and rats. Bacterial cultures of bovine bacilli, as well as emulsions of tuberculous lesions from thirty cases of bovine tuberculosis, were injected into strong, healthy animals previously tested with tuberculin. In some cases the introduction was made subcutaneously, in many, into the veins of the udder, and in others, by means of the food. In numerous cases of subcutaneous injection it was found that the proximal lymphatic glands soon became involved, that fever developed about the twelfth day, and that death took place from the twentieth to the fiftieth day. At autopsy there was found general tuberculosis of the glands and serous membranes, the lungs, liver, and kidneys. In some cases, however, there were merely local symptoms of but temporary duration without especial pathologic change at autopsy. These divergent results were explained by the introduction of varying quantities of infective matter and by a possible difference in the resisting powers of the animals. It was found, also, that those having been subjected to udder injection exhibited a considerable variation in the character of the resulting changes. In some cases death supervened quickly, with postmortem evidences of extensive tuberculous disease. Others displayed but local evidences of infection, which subsided after a short time. Five calves out of six sucking from infected udders showed signs of local and general tuberculosis, as did monkeys, pigs, rabbits, guinea-pigs, and goats after inoculation or feeding with bovine bacilli. More resistance was shown by dogs, cats, and rats. Sharply defined differences were displayed in the virulence of tubercle bacilli taken from fourteen cases of human tuberculosis and injected into animals. In one group general tuberculous changes were produced after inoculation of cows and the other lower animals employed in previous experiments with bovine bacilli. In this group there was but slight variation noticed in the virulence of the two types of bacilli. In another group, however, bacilli or tuberculous material taken from forty cases of human tuberculosis produced merely a slight local inflammatory change, with swelling of the nearest lymphatic glands. In some of these cases the injection of large quantities of infective material did not produce any evidence of a general advancing tuberculosis, either in cattle, cats, or dogs, although there were several instances of slight non-progressive organic involvement. Monkeys, as a rule, were found to be non-resistant. The Commission attributed the divergent results of these experiments to differences of animal resistance and to variations in the virulence of the inoculated material. The report of the Commission is summed up as follows:

"There can be no doubt that in a certain number of cases the tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis, and there also can be no doubt that, in the majority, at least, of these cases, the bacillus is introduced through cow's milk. Cow's milk containing tubercle bacillus is clearly the cause of tuberculosis. A very considerable amount of disease and loss of life, especially

among the young, must be attributed to the consumption of cow's milk containing tubercle bacilli. The presence of tubercle bacilli in cow's milk can be detected, though with some difficulty, if the proper means be adopted, and such milk ought never to be used as food. There is far less difficulty in recognizing clinically that a cow is distinctly suffering from tuberculosis, in which case she may yield tuberculous milk. The milk coming from such a cow ought not to form a part of human food, and, indeed, ought not to be used as food at all."

These conclusions are directly in accord with the opinions expressed by Drs. Schroeder and Cotton in this country. Their researches are reported in detail in "The Bulletin of the Bureau of Animal Industry of the United States Department of Agriculture," recently issued. They even affirm that a tuberculous cow constitutes an element of much greater danger to the health of the community than a human consumptive. Considerations pertaining to this subject will be later discussed at some length. In America, since the promulgation of Koch's doctrine, much interest has been attached to an investigation of the intercommunicability of human and bovine tuberculosis.

Ravenel called attention to the experiments conducted in 1901 by Chauveau, who finally succeeded in infecting cattle with bacilli of human origin. Well-marked tuberculous processes were found in three cows following the introduction of infectious material with the food and by means of intravenous injection. Upon subcutaneous inoculation of seven animals, however, in no case was there obtained evidence of general infection. Crookshank, in the same year, after inoculation of human tuberculous material into the peritoneal cavity of a calf, reported a positive result, as did Thomassen in 1901, after inoculation of the anterior chamber of the eye. Successful inoculations were conducted by Arloing in 1901 and de Jong and Nocard in 1902. Martin produced infection of four calves out of six by introducing tubercle bacilli with the food. In 1902 Ravenel reported the results of his own investigations, dating back four years. Of four calves inoculated with human bacilli into the peritoneal cavity, one exhibited pronounced illness during life and three showed at autopsy unmistakable evidences of tuberculous infection. An experiment of vast importance conducted by him was the inoculation of two calves with a culture obtained from the mesenteric gland of a child whose death resulted from tuberculous meningitis, but who exhibited clear evidence of a primary intestinal lesion, presumably of bovine origin. The utmost virulence characterized the infection in each instance, and a conclusion as to the probable bovine type of the bacillus appears eminently rational. He later published the reports of four cases of accidental infection of the hands with bovine bacilli, reference to which will be made in connection with the skin as a channel of infection.

S. von Ruck, in an exhaustive article upon the intercommunicability of human and bovine tuberculosis, takes exception to much of the inoculation evidence adduced by various observers in refutation of Koch's position. He points to possible sources of error and believes the results are subject to considerable criticism. He refers to the work of Waldenburg, Fox, Panum, Wyss, Cohnheim, Fränkel, and other contemporaries of Villemin, who severally succeeded in producing pseudo-tuberculosis after inoculation with non-infective material, or with tuberculous matter rendered innocuous by boiling and prolonged submersion

in alcohol. The substances injected consisted of metallic mercury, coal-dust, fresh blood of guinea-pigs, paper, lint, rubber, and pieces of sponge. It is probable, however, as pointed out by several observers at that time, to which reference has been made, that the opposition to Villemin resulted from imperfections of technic in the conduction of experiments, and that actual tuberculous material was introduced without the knowledge of the operator. It cannot be possible that such sources of error could obtain with experienced and skilful experimenters at the present time, especially when one considers the attainments of those who have conducted recent investigations. It is no reflection, however, upon the merits of the earlier observers to ascribe their results to obvious possibilities of error in their attempts to transmit artificial human tuberculosis to cattle. Although Prudden, Hodenpyl, and others have shown that the intravenous injection of dead bacilli may be followed by characteristic tuberculous lesions, this, contrary to the assumption of von Ruck, affords in itself no convincing argument prejudicial to the reliability of recent inoculation experiments. Attention has been called to the contention of Baumgarten concerning the impropriety of intravenous or intraperitoneal injection, and the greater advantage of subcutaneous inoculation. This is alleged upon the ground that the latter offers opportunity to study the advance of the infection through the lymphatics, and avoids the possibility of confusion resulting from embolism and consequent complicating pathologic processes, simulating tuberculosis of the peritoneum. Upon this basis von Ruck criticizes many of the recent inoculation experiments, charging erroneous conclusions in case of several intravenous injections, suggesting possibilities of incorrect interpretation of intraperitoneal inoculation, and emphasizing the negative results of a considerable number of subcutaneous injections. It is pertinent, however, to call attention to the fact, even if other considerations be waived, that such objections scarcely can obtain in case of inoculation into the anterior chamber of the eye, which procedure has been attended in many instances with a positive local and general infection. Furthermore, the very authority cited by von Ruck in partial support of his view, *i. e.*, Baumgarten, has been placed on record as maintaining strongly the close similarity of human and bovine tuberculosis despite his conception, in accord with Koch, of an actual resistance of cattle to infection with human bacilli. From the evidence presented it is reasonably safe to assert that while bovine bacilli undoubtedly possess a much greater degree of pathogenic virulence for cattle and other animals than the human variety, the latter are not shown to be innocuous upon injection. It may be assumed that human tuberculosis in occasional instances and under favorable conditions can be transmitted to cattle.

The doctrine of Koch that the bovine infection is rarely transmitted to human beings has been said to rest upon the alleged infrequency of primary intestinal tuberculosis in children, despite the ingestion of bovine bacilli in milk, butter, and other dairy products. The fallacy of this assumption is shown by the demonstrable proof of infection through the intestinal tract without the slightest trace of mucous membrane alteration. Calmette and Guerin have recently conducted elaborate investigations as to the frequency of infection through the alimentary tract without visible lesion of the intestine. On account of the prevalence of pulmonary tuberculosis it has been assumed that the respiratory tract

represents a much traversed port of entry for the tubercle bacilli. Previous views as to the infrequency of invasion through the alimentary canal suggested by the rarity of primary intestinal tuberculosis have been subjected to much modification as a result of their experiments.

Theobald Smith and others have called attention to the frequent primary involvement of the peribronchial lymph-nodes in tuberculous cattle. Calmette, Guerin, and Delearde introduced tuberculous material into the stomachs of animals by means of the esophageal tube in order to avoid the possible inhalation of bacilli. After a period of thirty to forty-five days the peribronchial lymph-nodes were found to have become infected through the medium of bacilli-laden leukocytes. A single infected feeding to calves resulted in the retention of the microörganisms for a time in the mesenteric glands, but subsequently they were conveyed to the mediastinal and retropharyngeal glands, in some instances even after a small dose. The mesenteric glands presented no macroscopic evidence of disease, but when injected into guinea-pigs, produced typical tuberculous lesions. Calmette and Guerin also reported several positive results of inoculation when use was made of the apparently normal mesenteric glands of children who exhibited no trace of tuberculosis, similar experiments having been conducted by Pizzini, Loomis, and others, with like results. In the event of continuous feeding with tuberculous material, the bacilli were found to enter the thoracic duct and pulmonary artery through the lymphatic circulation. Various inhalation procedures were employed, and bacilli were introduced directly into the trachea, but the resulting infection was uniformly slight and attributable chiefly to the swallowing of infected mucus or saliva. A noteworthy feature of these experiments was the priority of mesenteric glandular involvement over that of the respiratory system. A paramount importance was ascribed to infection through the intestine, and it was assumed that the tuberculous material was conveyed to the alimentary tract largely through the milk of infected cows, and as a result of food contaminated by human bacilli. Nicolas and Dorcas have shown that smears from the thoracic duct of fasting dogs taken three hours after an infected meal contained tubercle bacilli. If the above observations be accepted for their face value, any arguments relative to the rarity of infection through the intestine based upon the absence of local lesions at once falls to the ground. In this connection the thought is suggested, however, that, as cows are ruminating animals, especial opportunity for infection through the fauces, tonsils, and pharynx to the retropharyngeal glands is afforded by their habit of chewing the cud. It is quite possible to conceive in this manner of the ready entrance of the bacilli into the lymphatics and their direct conveyance to the retropharyngeal lymph-nodes.

Despite important contradictory evidence advanced by several investigators, notably Smith, the fact remains that in the light of the experiments of Calmette and Guerin it may be assumed that the intestine constitutes at least one of the very important routes of invasion by the bacillus. No proof has been adduced as to the infrequency of food contamination by bovine bacilli, while the facilities for such infection appear worthy of consideration. Thus any contention to the effect that infection through milk or other food-products can be assumed only when the intestinal or mesenteric glands are first involved is unwarranted. Medical literature, however, is replete with reports of primary intestinal

lesions in children, and of infection traceable more or less directly to milk from tuberculous cows.

In striking contrast to the statistical observations previously cited in support of the alleged rarity of primary intestinal lesions, and in opposition to the reports of Bovaird, Northrup, and a few European pathologists, are the conclusions of Councilman, Mallory, Pearce, Holt, Carr, Guthrie, Still, and Shennan. The autopsy findings in little children reveal a primary involvement of the intestine in a proportion varying from 17 per cent. to 37 per cent. These much quoted statistics are too familiar to the average reader to warrant an enumeration of their details. It is, of course, impossible to assert that infection in all cases was due to the bovine bacillus, as unusual exposure to the human bacillus is afforded to infants. Jensen and Fibiger have made elaborate researches concerning the frequency of primary tuberculosis of the intestine. A third report of their observations has been presented recently. Two cases are recorded of primary tuberculous lesions of the intestine in little children fed with milk from tuberculous cows. In one a striking feature with the onset of the symptoms was the simultaneous development of a local tuberculous lesion upon the udder of a cow. Inoculation of bacilli from these children into calves and rabbits, animals notoriously susceptible to bovine cultures and resistant to those of human origin, was attended with evidences of an exceedingly virulent infection. The above observers have collated and analyzed many cases from the literature of the subject, and affirm that the supposed rarity of primary intestinal tuberculosis, especially among children, is more or less mythical. While numerous writers have recorded instances of apparent bovine infection transmitted to children through the food, evidence is not lacking to demonstrate an equal, if not greater, frequency of infection among infants unaccustomed to other than mother's milk. Smith declares that if either the human or the bovine bacillus was completely eradicated from the world, the other would continue to induce the disease. Von Ruck very aptly has called attention to an increased prevalence of infantile tuberculosis in countries where the children are almost invariably breast fed. He cites the higher death-rate of children in Sweden and Roumania (Bâbes), Greenland (Heymann), China (Cobb), where cow's milk rarely is consumed by children, in contrast to the diminished mortality from tuberculosis in England, where artificial feeding is common.

Raw, upon the other hand, instituted inquiries in a great many foreign countries with a view to establishing a comparison between the distribution of pulmonary consumption and surgical tuberculosis in various localities. He reported that while pulmonary phthisis is rife even in countries where milk is not consumed by children, yet other forms of tuberculosis are extremely rare. Mayo has called attention to the relative infrequency of pulmonary tuberculosis in an agricultural community, although all forms of surgical infections abound, and ascribes the prevalence of the latter varieties to the ingestion of the bovine bacilli contained in uncooked milk.

The testimony from Japan is quite conflicting. Kitasato has been quoted by several writers to the effect that tuberculosis in cattle did not exist in Japan, and that milk was very little used as an article of food for children, although the disease actively flourished among the inhabitants. This statement has been corroborated by Asyama (Schoenborn), but

Shiga dates the development of tuberculosis in Japan to the importation of cattle in 1875.

Behring's theory as to the extreme frequency of human infection through tuberculous milk, though of much interest in this connection, is more properly a subject for later consideration. The comparatively recent discovery in milk and butter of pseudotubercle bacilli is perhaps explanatory to some extent of the not uncommon innocuous effect of ingesting supposedly infected dairy products. These microörganisms do not surrender their primary stain to inorganic acids, yet are incapable of producing tuberculous tissue change.

The morphologic and cultural differences between human and bovine bacilli have been pointed out very clearly by Theobald Smith and Ravenel. A comparison of their reports disclosed such uniformity of conclusions as to admit of no doubt concerning their accuracy. Smith stated: "The distinguishing characteristics in the early stages are: (1) The short, straight, somewhat plump, rod-like form of the bovine bacillus as contrasted with the long, more slender, and slightly curved form of the sputum or pulmonary type of the human bacillus. (2) The much greater tendency of the human bacillus to cohere in compact colonies or curved outlines." Ravenel reported that in early generations the length of the bovine is but little more than double its breadth, and agreed with Smith as to the characteristics of growth and the general disposition of the human bacilli in dense colonies. Smith has very recently called attention to the more abundant capsule of the human than the bovine bacillus. He finds that cold carbol-fuchsin is absorbed less readily by the bacillus of human origin. Bovine bacilli may exhibit a zone around each rod in which no stain has taken place, but the capsules are ill-defined in human bacilli on account of the close colonization. Behring has emphasized the fact that the toxin from the bovine bacillus is identical with that of the human tubercle bacillus. De Schweinitz was of the same opinion, as no difference was discovered in the reaction following the administration of tuberculin derived from human and bovine sources. In view of the vast array of clinical, pathologic, and bacteriologic evidence bearing directly upon the relation of the human to the bovine bacillus, the following conclusions appear inevitable:

1. That recognizable differences do exist in their morphologic and cultural attributes, but that these are not of such a nature as to establish a fundamental divergence in the character of the two microörganisms.

2. That the lack of perfect identity in these separate varieties of the same bacterial organism is occasioned by essential modifications of the host.

3. That the pathogenic virulence of the bovine form is much greater among animals than is the human bacillus.

4. That a correspondingly increased activity and pathogenic power of the bovine bacillus in comparison with the human thus far has not been demonstrated to obtain in human beings.

5. That, on the contrary, among individuals a greater virulence attaches to the bacillus of human origin than to the bovine.

6. That the practical dangers of infection from the bacillus of cattle are sufficiently real to justify no abatement of legislative, municipal, and individual measures to suppress the disease among domestic animals and afford protection to the human race.

CHAPTER IV

THE CONGENITAL METHOD OF INFECTION

The natural habitat of the tubercle bacillus is the living human or animal organism. Therein is provided a suitable medium with favorable conditions for growth and development. Although enabled to preserve its vitality for considerable periods outside the body, especially if not exposed to direct sunlight, it is, nevertheless, incapable of multiplication save within the host. Through a long process of reciprocal adaptation there has evolved an extraordinary parasitism on the part of the bacillus and an almost universal tolerance or receptivity to its presence by man. Both the bacillus and the living animal tissues having become more or less habituated to this relation, a tendency toward a state of stable equilibrium between host and parasite is established.

To maintain this relationship and preserve the existence of the microbe there must be afforded, as Theobald Smith has pointed out, ready means of entrance to the living organism and avenues of departure. It is apparent that the human and animal body is both the *final objective point* and the *source* of all tubercle bacilli dissemination. In this dual relation of receptor and donor of infection there exists the very essence of the problem of practical prophylaxis relating to a disease which has quietly assumed the proportions of a scourge.

It is necessary, therefore, to attain a clear understanding concerning the *various channels* of *entrance* of the bacillus into the human body, the *means* of *exit*, and the extent and manner of *distribution*.

The route of invasion of the bacillus has been for years the subject of a spirited controversy between the advocates of several widely differing theories, concerning the correctness of which there has been adduced in each instance much experimental and clinical evidence. It is clear that, from a practical standpoint, the determination of the precise manner in which the bacillus is introduced into the system is of infinitely less importance than the recognition of effective means to prevent its distribution after leaving the body. While a paramount interest attaches to the control of the bacillary egress from the body, considerable importance relates to the most frequented ports of entry.

The principal avenues of infection to which attention is directed are—(1) The congenital route of transmission; (2) the respiratory tract; (3) the alimentary canal.

Infection by inoculation and the various methods of invasion of special organs will be discussed in some detail in connection, respectively, with tuberculosis of the lymphatic glands (cervical, mediastinal, mesenteric), the bones and joints, the entire alimentary tract, the genito-urinary apparatus, the serous membranes (pleural, pericardial, and peritoneal), the skin, the larynx, ear, and nose.

HEREDITARY TRANSMISSION

Congenital tuberculosis, though known to be a demonstrable possibility, is relatively infrequent. In former years the influence of heredity as an etiologic factor was supposed to be of transcendent impor-

tance, some maintaining the existence of fetal tuberculosis, and others, merely an inherent predisposition to the disease at birth. For many years the inheritance idea was accorded a general acceptance. It early took deep root in the medical and popular minds on account of the common development of consumption among the children of tuberculous parents. Belief in the hereditary transmission of tuberculosis was also fostered by the pronounced nutritive disturbance frequently observed in the offspring of consumptive parents. Despite the absence of tubercle bacilli in the tissues or of definite anatomic lesions characteristic of tuberculosis, the numerous evidences of defective development in infancy corresponded closely to some of the clinical types of tuberculous infection. In early childhood the persisting enlargement of lymphatic glands, hypertrophied tonsils and adenoids, anemia, coarseness of features, slow dentition, and retardation of growth were thought to constitute reliable data in substantiation of an inherited tuberculous infection. Although the pendulum of medical opinion has since swung violently toward the doctrine of contagion, Baumgarten and his followers remain ardent advocates of the theory relating to direct transmission of the bacilli *in utero*. In support of their position may be stated: (1) The clinical and pathologic evidence pertaining to isolated cases of congenital tuberculosis; (2) the results of experimentation in animals; (3) the known latency of tubercle bacilli in the tissues of the body; (4) the development of the disease at a very early age; (5) the origin of the tuberculous process in portions of the body not readily accessible to infection from without; (6) the frequency of tuberculosis among the children of consumptive parents.

Before proceeding to a consideration of the several arguments bearing upon hereditary transmission it is well to review the manner in which congenital tuberculosis is possible of development. The primary source of the infection must be traced to the spermatic fluid, the ovum, or the placental circulation. Transmission through the medium of the spermatic fluid, though not susceptible of complete negative demonstration, is, however, clearly improbable. To permit of this occurrence it must be assumed that tubercle bacilli are not only present in the semen, but also in the nuclear material of the spermatozoön and in that particular portion with which the ovum is fecundated. Thus the element of probability is strongly opposed to a chance infection, even if bacilli exist in the seminal fluid. It is known, however, that this does not occur save in exceptional instances of tuberculosis of the seminal vesicles, testicles, and epididymis. As these conditions are often associated with sterility from mechanical causes, it is all the more difficult to conceive of bacillary transmission to the ovum through the semen. In advanced urogenital tuberculosis the occasional presence of bacilli in the spermatic secretion is not denied, yet no proof has been presented to substantiate the claim that they are present in the semen of pulmonary invalids devoid of such local infection. Several foreign observers have reported that bacilli were discovered in the testicles, epididymes, prostates, and seminal vesicles of patients who had died of pulmonary tuberculosis, and that portions of these organs were found infective to lower animals. This, however, affords no evidence in favor of the probable transmission of congenital tuberculosis by these individuals during life. It is obviously unsafe to submit for comparison pathologic data referable to the testicles of a corpse and the sexual and procreative pos-

sibilities of consumptives who are yet alive. It is to be noted, also, that numerous investigations by careful observers of the genito-urinary organs of phthisical patients after death have failed to disclose evidence of local tuberculous infection. Instances of primary infection of the female genital organs are sufficiently rare to cast much doubt upon the spermatic method of transmitting tuberculosis.

Experimental work of some importance has been conducted by Gärtner, Cornet, and more recently by Friedman. Gärtner, in a series of laboratory tests, found, after the injection of tubercle bacilli into the testicles of rabbits and guinea-pigs, that the artificially ejaculated semen not infrequently contained bacilli, but that this was incapable of transmitting tuberculosis to their young. The examination, both before and after birth, of many offspring of these animals having infected semen yielded in each instance a negative result. Cornet was similarly unsuccessful in like experiments, though, with Gärtner, he observed the development of tuberculosis in some of the females as a result of genital infection. Friedman, however, by injecting an emulsion of tubercle bacilli into the vaginas of rabbits quickly following coitus, found bacilli in the fetal organs at the end of six days. James assumes that this experiment is of striking value as affording conclusive evidence concerning the possibility of transmission through the semen. This does not appear to be quite a logical deduction, as even in the case cited the bacilli were not introduced into the ovum through and by virtue of the seminal fluid, but rather were injected in large numbers by external means. The presence of bacilli in no wise could be attributable to the seminal fluid, nor is the experiment analogous to the physiologic function of the genital organs.

But little evidence has been advanced concerning the possible transmission of the infection by the ovum. Baumgarten, after an artificial fecundation of the ovum of a rabbit with infected seminal fluid, was successful in finding bacilli in the ovum. Up to the time of his observation no bacilli had been found in the ovary. Various experiments have been conducted by him and Maffucci in the inoculation of hen's eggs with avian bacilli. These do not appear at all relevant, however, to a consideration of the congenital transmission of tuberculosis in man.

By far the most frequent method of intra-uterine infection is through the placental circulation. Even this is exceedingly rare, either in man or animals, and but few well-authenticated cases have been reported. Considerable confusion has arisen from the fact that infants born of mothers in advanced phthisis are subjected to exceptional opportunities for infection shortly after birth. A special predisposition to infection exists in such cases, and tuberculosis may develop with wonderful rapidity. It is important, therefore, to remove all doubt as to the possible extra-uterine origin of the disease before assuming its inclusion in the category of congenital tuberculosis. Obviously, in the great majority of cases this is attended with much difficulty. No uncertainty, however, is involved in observations relating to fetal and placental examinations, instances of unquestionable tuberculosis of these tissues being recorded. Well-defined tuberculous changes have been reported in the lungs, liver, spleen, pleura, and peritoneum of infants dying a few days after birth, and in the placenta of mothers who were in the last stages of consumption. It has been reported that despite the normal appearances of fetal organs and of the

placenta, positive results have followed the inoculation of animals with portions of these tissues. The same is true of injections of blood from the placental circulation. In contradistinction to these observations a large number of similar experiments have been performed without the production of tuberculous infection in lower animals. Portions of the organs of still-born infants from tuberculous mothers have been injected repeatedly into the peritoneal cavity of guinea-pigs and rabbits without success. Small animals during pregnancy have been infected virulently with human tubercle bacilli and the progeny in only a small proportion of cases were found to be tuberculous. Instances of reported congenital tuberculosis have appeared to be more frequent in animals than in human beings. In view of the separate placental and maternal circulations it may be assumed that the transmission of tubercle bacilli from a consumptive mother to the fetus *in utero* cannot occur save as a result of such pathologic change in the structural relations as will permit an abnormal communication between the two. It is comprehended that this may take place either with or without localized tuberculous processes in the placenta. It is probable, moreover, that the toxins which have accumulated in the placenta may be transmitted to the fetus without the bacilli. Bossi believes that the toxins thus entering the fetal circulation are largely responsible for the physical weakness and defective development of many infants, having diminished resistance to tuberculous infection. In his experience as an obstetrician he has had opportunity to examine and subject to animal inoculation a large number of fetal organs, as well as placental tissues, from patients in advanced phthisis, and seldom has he found involvement of these structures.

Irrespective of the clinical and experimental evidence adduced to substantiate the possibility of congenital tuberculosis, it is well to consider the inferential arguments which have been presented as suggestive of intra-uterine infection. The prolonged latency of bacillary infection, particularly in the glandular tissues, without producing active symptoms until a remote period of diminished resistance, is often regarded as indicative of a congenital invasion. The basis for belief in latent glandular infection is the recognition of tubercle bacilli in bronchial and mesenteric lymph-nodes which are macroscopically intact. A more detailed reference to these findings will be made in connection with glandular tuberculosis. The reports of Pizzini and others, to which reference is made elsewhere, demonstrate conclusively the not infrequent presence of bacilli in these structures, apparently without unfavorable consequences. Portions of glands taken from patients who have died of other diseases without displaying traces of tuberculous infection have been injected into animals with positive results. Rabinowitch has recently reported an interesting and instructive experience in connection with the mediastinal glands of patients clinically free from tuberculosis. The glands had been the seat of inflammatory processes, evidently resulting from the initial infection, and had undergone subsequently a degenerative change, becoming so calcified as to present the hardness of stone. Inoculation of lower animals, however, resulted in the development of definite tuberculous infection. In these cases the period of latency of the bacilli must have been very prolonged. Such an observation is opposed directly to the view of Cornet, who, although admitting the existence of tuberculous glands without macroscopic change, argues against a so-called latency of any considerable duration. He disputes a disproportionate longevity of

the bacillus in glands as compared with tuberculous processes in general. He asserts that there is not sufficient proof that tubercle bacilli may retain their virulence for years and yet remain in the body as innocuous non-multiplying parasites without encapsulation. He evidently does not believe that their prolonged sojourn in the glandular tissues, even if true, can be considered an effective argument in favor of their intra-uterine origin. Despite his protests, there appear to be ample clinical and experimental data in support of a belief in latent infections of very prolonged duration. Huebner has recently reported that tubercle bacilli are agglutinated by the blood of many non-tuberculous children. This at least may be regarded as provisional evidence concerning the existence of latent foci of infection. The blood from the umbilical cord was reported never to agglutinate the bacilli. The lowest percentage of agglutination was found in children entirely devoid of clinical evidences of tuberculosis, and the highest, in those presenting suspicion of a scrofulous taint. A high percentage was also found in those with hypertrophied tonsils and adenoids. Salge has reported that the blood of babies under one year of age without suspicion of tuberculosis agglutinates tubercle bacilli in 12.5 per cent. of cases. Schkarin records a positive result of the agglutination test in 21.4 per cent. of non-tuberculous children. From these reports it must be admitted that latent foci of tuberculous infection are much more common in little children than is generally supposed. It hardly follows, however, that this should be regarded as proof of hereditary transmission, although the evidence, as to an increased inherited predisposition, is quite conclusive.

The frequency of the disease at an early age, however, is irrefutable and is responsible in a measure for Baumgarten's contention. Mortality statistics are extremely high, particularly after the last quarter of the first year, and increase progressively with each year of life up to the age of fifteen or sixteen. It must be remembered that infants are remarkably susceptible to tuberculous infection, and that, as a rule, the course is excessively rapid. It would appear that but little resistance is offered to the onward progress of the bacillus. It is well known that the tissues are much more delicate in structure and more easily permeable by bacilli than in adults, and that the lymphatic spaces are proportionately larger, offering less obstruction to the advance of the infection. It seems difficult to reconcile these established facts with a theory of the congenital transmission of the microörganism as well as of the toxins. If the latter be conceded to restrict development and impair resistance, there could scarcely continue an indefinite period of bacillary infection without clinical evidence of the disease. That latent tuberculous foci do exist in many cases is beyond dispute, but it may be questioned properly if the sources of infection in such cases are not extra-uterine rather than congenital. This hypothesis is the more reasonable in view of the negative evidence previously presented regarding the infrequency of tuberculosis *in utero*. In this manner an explanation is afforded as to the existence of latent infection in children which is impossible of rational interpretation from an acceptance of the doctrine of hereditary transmission. Baumgarten, in his advocacy of the inheritance idea, has adduced two arguments to substantiate his position, which are evidently opposed to each other. He advances the theory of a widespread latency, and, at the same time, points to alarming statistics of infantile death from tuberculosis. The former is explainable only

upon the assumption of a perfectly established defense on the part of an organism infected prior to birth, and the latter upon the belief in a relatively diminished resistance at this time of life. Upon the other hand, the opponents of his theory can easily reconcile the existence of latent tuberculous infection in some children to their relatively increased powers of defense. The general frequency of the disease among the very young may be explained in part by the unusual opportunities for extra-uterine infection arising from the almost ubiquitous distribution of the bacilli and the peculiarly irresponsible habits characteristic of this age. The possible sources of infection at this time of life are almost infinite, and include the indiscriminate fondling by tuberculous individuals. the contamination of milk and other foods, the playing upon the floor or ground, and the placing of miscellaneous objects in the mouth. Considerations pertaining to the early infection of the very young through the alimentary and respiratory tracts will be reserved for later discussion. That these channels constitute important methods of infection in little children who are born healthy is impossible of controversion.

The fact concerning which all observers agree is the lamentably high death-rate in infants from tuberculosis. Botz has reported 2576 autopsies in tuberculous children, of which 27.8 per cent. died the first year. Other statistical observations of a similar nature will be given in connection with glandular tuberculosis. Dietrich, of Berlin, from a recent analysis of the official publications of the Prussian statistical office, reports that "there are a greater number of actual deaths from tuberculosis in the first year of life than in any other age period." He further states that there has been no actual decrease in the number of deaths from tuberculosis among infants in Prussia during the last ninety years. While the total mortality rate in that country from tuberculosis has diminished one-third during the past thirty years, there has taken place curiously a slight increase in the relative number of deaths from this disease in the first year of life, thus showing the disproportion existing between this and other age periods. Despite the active educational propaganda now being instituted in Prussia, it is evident that a pronounced further diminution of the total death-rate from tuberculosis can be secured only by effective measures to limit the infection in infancy.

Grancher, of Paris, after an examination of 4226 school-children, has recently reported that 15 per cent. were found tuberculous. Roeder, of Berlin, as the result of systematic examinations, found a surprisingly large number of school-children with incipient tuberculosis. Chalmers, from an investigation of the frequency of tuberculosis among the children of Glasgow, reports that there is a direct relation between the prevalence of the disease and the increase of poverty. School-children belonging to families occupying three rooms were found tuberculous in 3.4 per cent. of all cases; if two rooms were used, in 5.9 per cent., but if a single room, in 8.3 per cent. Upon the basis of all available evidence it is apparent that while there exists an alarming prevalence of tuberculosis among children, it is probably attributable to external conditions rather than to intra-uterine infection.

The localization of the tuberculous lesions among children in portions of the body not readily accessible to external infection is regarded by some as suggestive of a congenital origin. It is a matter of clinical record that at this age the tubercle bacilli display a special predilection for the invasion of glands, bones, and joints. Baumgarten assumes that

such localization must be of accidental development if not occasioned by transmission *in utero*, but disclaims the former, both on account of its improbability and on the ground that the bacilli always produce some lesion at the point of entry. It is well known, however, that lymph-nodes are often invaded without visible lesion at the infection atrium, whether this be the tonsil or the intestinal, pharyngeal, and bronchial mucosa. In a large number of cases the lymph-nodes are the primary seat of the tuberculous process, as was pointed out by Weigert twenty years ago. Harbitz offers corroborative testimony by referring to the general experience of pathologists to the effect that in children isolated tuberculous processes are rare without coincident or prior infection of the bronchial glands, while involvement of the latter without pulmonary disease is not infrequent. Ribbert and Petruschky assert that, in the great majority of cases, tuberculosis of the lymph-glands in children antedates infection elsewhere. Cnopp has shown that 147 children out of 298 victims of tuberculosis had bone or joint disease, with only eight of these exhibiting infection of the internal organs. Numerous statistical reports have been recorded by observers as to the relative frequency in children of tuberculous processes in various portions of the body. Some of these analyses will be presented in connection with tuberculosis of special organs. Upon the whole, it is noteworthy that the lymphatic glandular structures are infected in a very large proportion of cases, and that the evidence in many instances has pointed to their primary involvement. This, however, cannot be considered an argument in favor of congenital or hematogenous invasion. Bacilli are known to penetrate intact mucous membranes and gain entrance to proximal glands without clinical evidence of disease. Furthermore, were the infection derived *in utero*, it would be supposed that the liver and abdominal viscera should represent the primary seat of the disease, but these organs are found involved in children much less frequently than other portions of the body.

Perhaps the greatest factor in the evolution of the belief in hereditary transmission has been the oft-noted development of tuberculosis in succeeding generations. Williams records a family predisposition in 48.4 per cent. out of 1000 cases of consumption, but this report is divested of much of its significance when he adds that only 12 per cent. were parental and 1 per cent. grandparental, the remaining 34.4 per cent. being of collateral relation. Solly reported, from an analysis of 250 cases, 28.8 per cent. with a history of parental tuberculosis. My own observations, based upon an analysis of 2070 cases, show a family history of tuberculosis in 518, or 25 per cent. Of these, 398 were instances of parental tuberculosis and 94 of grandparental. In 26, tuberculosis had existed both in parents and grandparents. The influence of heredity will be further discussed in another connection.

A noteworthy feature of this subject is the infrequency of tuberculosis in orphan asylums, in which one would naturally expect such a disease to flourish if hereditary influence could be assigned as a factor of especial etiologic importance. Congenital tuberculosis, though an admitted possibility, must be regarded as of rare occurrence.

CHAPTER V

INFECTION BY WAY OF THE RESPIRATORY TRACT

The inhalation theory of tuberculous infection for many years was accorded a quite general acceptance. This method of invasion of the body by the tubercle bacillus appears upon superficial thought an eminently simple and natural explanation of localized tuberculous processes within the lung. So reasonable and apparently satisfactory a conviction concerning the origin of the disease in the overwhelming majority of cases has been rudely disturbed by the results of recent clinical, pathologic, and experimental investigation. The older articles of faith regarding this mode of infection, which hitherto have been subscribed to almost universally, are now the subject of an animated controversy. A spirited discussion has arisen involving the frequency of respiratory infection. Some, as a result of considerable research, are inclined to repudiate in toto the inhalation theory of bacillary invasion and to accept the alimentary tract as practically the exclusive channel of infection. Others, while not denying the sustained logic of newer anatomic study, embrace the belief that but an occasional path for the bacillus is afforded by the gastro-intestinal canal or the pharynx, and insist that such admission detracts nothing from the tenability of former views. They still adhere to the opinion that the respiratory tract constitutes the principal avenue traversed by the bacillus in entering the body. It is significant that even among the advocates of this theory some violent discussions have taken place with reference to the precise manner in which the microörganism is permitted to gain entrance into the lungs through the inspired air.

Cornet was an early exponent of the doctrine that inhalation infection took place solely through the conveyance of tubercle bacilli with contaminated dust to the terminal bronchioles and alveoli by means of the respiratory current. The essential element of danger attaching to tuberculous sputum was regarded as attributable exclusively to its *dryness*. Thus the presence of a consumptive as a source of possible contagion to others was believed to be of serious import only in the event of a careless disposal and drying of the sputum. The possibility of infection through the expired air of a pulmonary invalid was forthwith discredited. Flügge and his pupils, however, have shown conclusively that consumptives in the act of coughing, and even of loud talking, may disseminate a fine spray containing tubercle bacilli. The demonstration of this so-called droplet infection is regarded by many students as suggesting that the disease is transmitted chiefly through *moist* particles of sputum. Accordingly, there is observed in some quarters a tendency to minimize the danger of transmission of tuberculosis through the expectoration. This, however, is attended by a corresponding modification of previous opinions relating to the harmlessness of contact with careful consumptives. This later belief in the distribution of bacilli through the exhaled air has fostered an exaggerated notion as to the actual likelihood of infection arising from close proximity to pulmonary invalids.

Before discussing the relative merits of the theories of transmission from moist and dry sputum it is well to consider the general proposition regarding the respiratory tract as an avenue of tuberculous infection, and to review the evidence upon which may be based an assumption as to its practical importance. The arguments which have been adduced from time to time in support of the inhalation method of infection have been: (1) The supposed frequency of primary pulmonary involvement and the assumed rarity of primary intestinal tuberculosis; (2) results of experiments upon animals; (3) the prevalence of consumption among inmates of prisons and other institutions; (4) the repeated coincidence of the disease in the same apartments among tenement districts.

These affirmative contentions are worthy of a brief consideration seriatim. Supporters of the inhalation theory have pointed to the lungs and bronchial glands as the primary foci of disease in the vast majority of instances. Complicating lesions in other parts of the body were recognized as more recent manifestations. It should be understood, however, that no evidence has been presented to suggest that involvement of the lungs *precedes* a tubercle deposit in the bronchial glands. On the contrary, from the available data it is reasonable to conclude that the direct reverse is the case. The observations of Weigert, Harbitz, Ribbert, and Petruschky concerning the relation of lymph-node tuberculosis to pulmonary involvement have been referred to in the previous chapter. Many pathologists agree as to the much greater frequency of *isolated* tuberculous processes in bronchial glands than in pulmonary tissues. Smith, in an exhaustive study of tuberculosis in cattle, while averring that the usual method of infection is through the inhalation of tubercle bacilli, yet states that the chief seat of the lesion is in the lymph-nodes. In many herds examined by him there were found several animals exhibiting no tuberculous lesions whatever save lymph-node disease. In one herd of sixty animals fifty-three were found tuberculous, and of this number twenty-seven had well-defined involvement of thoracic lymph-nodes without pulmonary infection. The only satisfactory explanation of such an occurrence in harmony with the theory of inhalation infection is a primary invasion of these structures after the penetration of an intact mucous membrane. This Smith readily concedes, but believes the passage of bacilli to the mediastinal glands in cattle to be largely through the tracheal or bronchial mucosa.

While it is true that an involvement of certain chains of lymphatics is the best evidence of the route of invasion through corresponding drainage portals, it does not follow that infection must take place invariably through such channels. There is abundant evidence, as shown in preceding chapters, to the effect that tuberculosis of the bronchial glands readily occurs without the respiratory tract serving as a port of entry. Given a primary tubercle deposit in the bronchial glands, it still is open to argument if such invasion be attributable in general to the penetration of the bacillus through the mucous membrane of the respiratory tract. In view of the experience of Calmette and Guerin, previously alluded to, and the recent observations of Jonathan Wright, Schlossman, and Engel, it appears perfectly rational to assume that a most important lymphatic pathway of glandular invasion is through the pharynx and digestive canal. While no positive evidence has been presented to substantiate the claim of an invariable invasion through

the peribronchial lymphatics, it has been demonstrated definitely that the microörganism may gain entrance to the lymphatics through the pharynx or intestine and advance to the glandular structures after the lapse of a few hours. On the other hand, considerable negative testimony has been adduced with reference to the ingress of bacilli to the mediastinal lymph-nodes through the tracheal and bronchial mucosa. The old assumption that the bronchial glands were infected by the passage of the bacilli to those structures from the pulmonary tissues has been generally abandoned. It is clear that the lungs may become the seat of tuberculous infection by extension *from* mediastinal glands, but whether or not the tubercle bacilli pass in large numbers through the tracheal and bronchial mucosa to the proximal lymphatic glands must remain for the present *sub judice*. Among the various considerations having a negative bearing upon this subject should be mentioned the futile attempts to induce pulmonary tuberculosis by the injection of large quantities of bacilli into the trachea, and the other inoculation experiments of Calmette and Guerin, Nocard and Rossignol. On account of the defensive action of the ciliated epithelium in sweeping outward offending agents, the tubercle bacilli are enabled to penetrate the mucous membrane of the respiratory tract less readily than that of the intestine. It has been claimed, in opposition, that the presence of fine particles of dust or soot in the bronchial tubes and adjacent glands is convincing evidence of the ease with which microörganisms may be similarly conveyed. As the terminal bronchioles and alveoli are equipped less formidably with cilia than the large and medium-sized bronchi, it is further contended that those particles of dust and bacteria which eventually gain entrance to the finer bronchioles are ejected with greater difficulty and are frequently permitted in these portions to obtain a lodging-place. In apparent corroboration of these theories Cornet has succeeded in producing tuberculosis in guinea-pigs by exposing them to dried tuberculous sputum. After depositing pulverized sputum upon a carpet in a room of 76 cubic meters, he placed forty-eight guinea-pigs at various distances from the floor and obtained characteristic lesions of tuberculosis in forty-seven. Although Villemin, Koch, Tappeiner, and Thaon also succeeded in producing tuberculosis of bronchial glands in this manner, several other experimenters failed to produce infection of animals through inhalation exposure. Findel has recently demonstrated that, after the performance of tracheotomy upon dogs and calves, the direct inhalation of tubercle bacilli has been followed by tuberculous infection, and that the number of bacilli necessary for this purpose is apparently less than the amount required to accomplish a similar result through the digestive tract. It is apparent, however, that quantitative estimates of this character, based upon the injection of bacilli directly into the bronchi of tracheotomized animals, are scarcely analogous to conditions of ordinary respiration and are subject to many possibilities of error. Several subsequent attempts have been signally unsuccessful. Flügge asserts that, after inhalation experiments, the inoculation of guinea-pigs with the peripheric portions of the lung is followed by the development of tuberculous infection, apparently corroborating a belief in the entrance of bacilli to the finer bronchi through the process of inhalation. Although the possibility of transmitting tuberculosis to guinea-pigs confined in small cages and compelled to inhale an atmosphere laden with bacilli is admitted,

it does not follow that the ordinarily inspired air of human beings conveys tubercle bacilli to the finer bronchioles, there to penetrate the mucosa. In man the sole consideration relates to the *accidental* introduction of the tubercle bacillus into the respiratory tract, which assuredly is not analogous to the enforced inhalation of innumerable bacilli within a confined space. It is important to note that the pulmonary infection developing in animals as a result of inhalation experiments in no way corresponds to the development of tuberculosis among human beings. It is not without significance that the involvement thus induced in animals is not confined to the apical region, but is distributed more or less uniformly over the entire lung. The bacillary content of the air is assuredly much less than the fragments of impalpable dust, and these, as a rule, do not proceed unmolested by the cilia to the ultimate bronchi. In fact, Van Steenberge, Grysez, and others have failed to produce pulmonary anthracosis in animals by the compulsory inhalation of air saturated with soot, and have reached conclusions directly opposed to those of Arnold, Ponfick, Fleiner, Muscatello, and other previous observers. The later investigators assume that this condition arises from the swallowing of particles which have accumulated within the nasopharynx or pharynx. They assert that, upon the introduction of soot into the stomach by means of the esophageal tube, thus precluding the possibility of inhalation infection, the presence of these particles is speedily recognized in the mesenteric and mediastinal glands. In connection with this experimental data Smith introduces an element of uncertainty by calling attention to the daily ingestion of large quantities of dirt by domestic animals. While the mesenteric and mesocolic lymphatic nodes of the non-fastidious pig are not pigmented, it should not be forgotten that the uncleanly habits of this animal pertain more to the ingestion of organic filth than of soot or non-organic dust.

In long-standing cases of pneumonokoniosis the presence of fine particles of dust in the ultimate bronchioles has been cited by some as satisfactory proof of the entrance of tubercle bacilli into these portions of the respiratory system in the act of inhalation. It should be remembered, however, that such condition exists only from greatly prolonged and excessive exposure to a mineral dust capable of exciting mechanical disturbance. For its production there are associated conditions of atmospheric vitiation, an excessive amount of dampness, a non-vitalized and confined air which is contaminated by smoke, carbon dioxid, and other impurities.

Again, the resulting effects are not incident merely to the inhalation of dust. There often develop in the pulmonary tissues certain structural lesions, permitting in themselves a degree of dust retention not possible in normal conditions. As a result of these influences there gradually take place atrophic and nutritional changes in the mucous membranes, with a destruction of the superficial epithelium. As the emphysema and chronic bronchitis progress, opportunity is afforded for the accumulation of sooty particles, this being, however, in no way analogous to ordinary conditions of respiration. It is of further interest to note that anthracotic conditions are not restricted necessarily to apical portions of the lung, as often asserted, the bases being involved quite frequently even in early stages (see Plate 9). For the above reasons the citation by Cornet and others of anthracosis as properly

illustrative of the mechanism of infection with tubercle bacilli is obviously inapt.

The usual localization of tuberculous lesions *at the apex* is almost irrefutable evidence against a direct inhalation of bacilli to the remote bronchioles and alveoli. If such were the manner of infection, it would be reasonable to suppose that the initial tuberculous processes should be distributed more or less uniformly over the entire pulmonary area. Upon the assumption of immediate inhalation infection without the intervention of the bronchial glands it would be necessary, as formerly, to attribute the circumscribed lesions at the apex to such generalized and indefinite causes as are expressed in the convenient phrase, "*locus minoris resistentiæ*." If impaired respiratory effort and diminished blood-supply at this point serve as a satisfactory explanation concerning the development of tuberculosis in a single portion of the lung, despite an equal and proportionate dissemination of the bacilli throughout the respiratory tract, it is difficult to account for the essential difference in the localization of the tuberculous processes in children and adults. It cannot be that the vicinity of the hilus and the base, portions of the lung notoriously involved in children, are more subject at that age to diminished blood-supply or to deficient expansion. Again, if such causes are conceded to exist at the apex, it is hard to understand why lesions at that point are prone to heal with more or less rapidity. It is apparent that a more rational explanation of the site of the tuberculous lesions is demanded than the hypothesis of a weakened local resistance, applying to a single portion of the lung in adult life, despite a generous and indiscriminating distribution of bacilli, with, however, a different location of early infection in children. Upon the basis of a prior infection of cervical and bronchial glands, irrespective of their route of invasion, whether from pharynx, tonsil, trachea, bronchial tube, or intestine, it is possible to reconcile a unilateral apical extension in adults by means of the blood-channels and lymphatics. Though perhaps not susceptible of proof, it is at least a reasonable assumption that involvement of an apex may proceed in some instances from initial invasion of cervical glands, and this thought is in line with the results of some clinical observations. In the event of extension from bronchial and mesenteric glands, however, the theory of Aufrecht to the effect that the bacilli are carried through the circulation until arrested at the apex in the terminal pulmonary arteries is probably true. All experiments relating to the feeding of tuberculous material to animals and the subsequent discovery of the tubercle bacilli in the thoracic duct and veins, as previously described, tend to substantiate the hematogenous nature of the apical invasion. The localization of the process in children is undoubtedly occasioned by the direct lymphatic infection from the bronchial glands. The lymphatic spaces, being proportionately larger and more permeable at this age, should permit a ready extension to the contiguous portions of lung. The blood-stream is known to be an important channel for the transmission of the infection to the apex in adults, and the preponderance of evidence points to the usual route of tuberculous invasion at all ages through the blood-vessels and lymphatics. It would appear, however, that in infants the conditions are such as greatly to facilitate a direct advance of bacilli without recourse to the blood-stream.

The supposed rarity of intestinal tuberculosis, which formed a basic

argument in favor of the inhalation theory, has proved to be more or less incorrect. Primary intestinal tuberculosis is known to be more frequent than was formerly supposed, and, in addition, the necessity of local lesions at the point of entry is no longer recognized.

On account of the exceptional opportunity offered for infection the greater prevalence of tuberculosis among the inmates of institutions has often been cited to support the view of inhalation transmission. It is not comprehended why an increased danger of conveyance is referable entirely to infection by inhalation. It goes without saying that added possibilities of transmission accrue from the close contact of consumptives with a large number of people within a relatively confined space. This does not in itself, however, involve necessarily the acceptance of a single method of infection to the exclusion of all others. From the manifest opportunities for transmission, together with a combination of conditions inevitably lessening individual resistance, it is apparent that infection must result irrespective of the precise mode of invasion. The citation of such statistics, therefore, to sustain a theory of inhalation infection is insufficient for this purpose unless accompanied by other data of a more definite nature. While tuberculosis has been found to flourish in prisons, convents, and similar institutions in which the inmates are subjected to varying degrees of close seclusion, it is also true that the disease has developed more frequently among those committed to solitary confinement. The fact that amidst such surroundings the more restrictions placed upon social relations, the more prevalent the disease, is presumptive evidence, not of the dangers of inhalation infection *per se*, but rather of the preponderating influence in such cases of an added vulnerability of the organism to an infection previously latent. On the other hand, there is a wide divergence in statistical observations pertaining to the transmission of tuberculosis to nurses and attendants in various consumptive hospitals. The Brompton Hospital for Consumptives many times has been referred to as illustrative of the comparatively slight danger of contagion. The same is true of Dettweiler's Sanatorium at Falkenstein. I have never observed the occurrence of tuberculosis among nurses or employes in any of the institutions inhabited by pulmonary invalids in Colorado, but not infrequently have become cognizant of its development in nurses at work in general hospitals elsewhere. It would appear that the essential element in such cases is the individual equation and the nature of the general environment, rather than the mere matter of contact with consumptives.

The same method of reasoning applies in large measure to the reported coincidence of tuberculosis from time to time among the occupants of the same apartments in the closely populated tenement districts of large cities. The distribution of consumption in a single ward in Philadelphia during a period of twenty-five years has been studied by Flick, who established the fact that the disease has developed repeatedly among the changing inhabitants of the same abode. His researches have been generally accepted as evidence of the iniquitous rôle of the house in the transmission of tuberculosis. Without any desire to detract in the slightest degree from the acknowledged value of his observations or to minimize the dangers of house infection, it is perhaps fitting to inquire if a repetition of phthisis in the same apartments is sufficient to justify an assumption that the contaminated dust of dwellings constituted the all-

important source of infection. More than one case of tuberculosis was found to have occurred in 33 per cent. of the infected houses in this ward during a quarter of a century. It must be remembered that the district was populated densely, the conditions frequently unsanitary, and the inhabitants, as a rule, unpossessed of marked powers of resistance. The majority were working-people accustomed to long-continued privation. Many children, as well as adults, were compelled to undergo strenuous hardship, and subjected to prolonged hours of toil, in poorly ventilated workshops, only to return at the end of the day to overcrowded and ill-smelling homes. Without adequate instruction as to necessary precautions, without sustaining food, or proper facilities for healthful recreation, it assuredly appears inevitable that consumption would be widely prevalent in the midst of such surroundings. In view of these unusual conditions it is somewhat remarkable that in twenty-five years a larger number of houses did not chance to harbor more than a single case of consumption. It is questionable, upon the face of the returns, if the factor of supreme importance in the prevalence of the disease among succeeding occupants is justly attributable in these cases to the accumulation of virulent dust.

Even if the theory of inhalation transmission be accepted, it has been shown, by the researches of Flügge and others, that dry sputum dust does not constitute the sole element of danger. Flügge believes that the inspiration of an atmosphere containing tubercle bacilli is a frequent means of infection, but takes issue with Cornet and his followers as to the practical degree of danger arising from the contamination of air with bacilli-laden dust. It is admitted by Flügge and his pupils that inhalation infection may occasionally develop in children, though rarely in adults, by the handling of handkerchiefs and clothing upon which sputum has been deposited, permitted to dry, and later brought into contact with the mouth. It is believed, however, that the presence of bacilli in the air after separation from the sputum is comparatively infrequent. It would seem that if the inhalation theory of infection is conceded to be an important mode of transmitting the disease, it is folly to deny the possibilities of contagion arising from sputum dust be it deposited upon the floor, rugs, draperies, clothing, handkerchiefs, hands, or beard. The careless and indiscriminate agitation of the dust incident to the ordinary methods of house-cleaning are manifestly sufficient to effect an introduction of bacilli with the inspired air. Flügge originally ascribed the principal manner of infection to the inhalation of bacilli contained in fine particles of sputum ejected from the mouth of consumptives in the act of coughing and loud talking. According to this theory, the air in the immediate vicinity of the pulmonary invalid is frequently loaded with tubercle bacilli. Numerous experiments were conducted by him as well as by Fraenkel, Huebner, Moeller, Kirstein, Schoeffer, Heymann, Hillier, and Ravenel. Huebner, after rinsing the mouth with a suspension in water of the bacillus prodigiosus, placed agar plates before the lips, and upon counting loudly up to 375, developed 119 colonies. Seventeen were produced by whispering up to 360, while 41 colonies were obtained by counting in an ordinary tone up to 550. A few colonies were developed by removing the plate twenty inches from the mouth.

Schoeffer induced lepers with well-defined lesions of the mouth and throat to speak for ten minutes in front of glass slides and demonstrated

the presence of numerous lepra bacilli which had been projected with fine invisible particles from the mouth. It is well to note that in these experiments numerous bacteria were contained within the mouth of the individual. This condition, however, does not obtain, as a rule, among consumptives save in the very act of coughing. Heymann has shown that the droplets ejected at such a time are infective to guinea-pigs. Flügge recently made experiments upon thirty patients and found an average of several hundred tubercle bacilli suspended in the air within a radius of 40 to 80 centimeters from the consumptive within a period of thirty minutes after the act of coughing. In some of these cases as many as 20,000 tubercle bacilli were estimated to be present. He does not regard the zone of danger under ordinary circumstances to exceed three feet from the infected individual, but believes this to be much greater during violent paroxysms of coughing. Moeller reports the finding of bacilli upon the eye-glasses of his assistant, as well as on the head-mirror and cheek, after an examination of patients with tuberculosis of the larynx. Sangman, of Copenhagen, disputes the practical danger of such infection upon the ground that, were this the case, lung specialists and laryngologists would become the subjects of tuberculous disease far more frequently than at present.

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During a physical examination, as the patient is frequently urged to cough as a means of more accurate diagnosis, it would appear that the physician must be in the very midst of an atmosphere capable of producing a virulent infection. If the examiner, in the course of his daily work, is exposed for many hours to droplet infection, it must be evident that the prevalence of the disease among phthisiotherapeutists is much less than might be expected. The infrequency of tuberculous disease among laryngologists is partly explained by the short period of examination, the protection afforded by glass plates, and by the inability of the patient, as pointed out by Ziesche, to secure any forceful intratracheal pressure with the epiglottis open, as is the case during examination. The practical bearing of the droplet infection, which must be regarded as an accepted fact, relates not only to the possibilities of inhalation transmission, but as well to the added danger of food contamination. No explanation is required to demonstrate the ease with which bacilli may be deposited upon the food in the midst of its preparation or during the course of the meal.

While it does not appear rational to deny the probability of the occasional transmission of tuberculosis through the process of inhalation, a careful review of the evidence fails to substantiate, in a perfectly satisfactory manner, a belief in the respiratory tract as the *principal* route of bacillary invasion.

A judicious skepticism is never prejudicial to an honest, scientific inquiry, while a complete acceptance of an alluring and time-honored theory, if unsustained by positive proof, is not in accord with the fundamental principles of modern medicine. It is important to bear in mind that in the present controversial difference of opinion the practical consideration relates not to the possibility of inhalation or of ingestion infection, but rather to the relative frequency and importance of these two channels of invasion. Belief in frequent infection through the respiratory tract does not constitute *per se* any justifiable basis for the rejection *in toto* of the digestive canal as an important route for the

tubercle bacilli. *Per contra*, absence of demonstrable proof that inhalation represents the principal method of invasion does not warrant an assumption as to the predominating importance of ingestion tuberculosis. It is submitted that a critical analysis of available data should be inspired by no preconceived notions, but rather conducted in a spirit of receptive inquiry.

CHAPTER VI

INFECTION THROUGH THE DIGESTIVE TRACT

Irrespective of essential differences of opinion entertained regarding the transmission of tuberculosis to human beings through the process of inhalation, and waiving any further consideration of the relative dangers from the inspiration of dry dust or moist droplets, the fact remains that tubercle bacilli contained in human sputum constitute a vitally important source of contagion. This introduces a phase of the subject pertaining to invasion through the alimentary canal which it is desired to emphasize, *i. e.*, that the theory of transmission of the disease through this channel does not imply the presence of the bovine bacillus as the sole or principal agent of infection. Quite to the contrary, it may be asserted that in a large majority of cases gastro-intestinal infection is produced by the entrance of bacilli derived from tuberculous sputum. While the tubercle bacillus of bovine origin is, beyond question, an important factor in the causation of tuberculosis among infants, this bacillus does not represent the only element of danger, even among children. It produces a comparatively infrequent and non-virulent infection in adults. It is desired to avoid any possible impression that the digestive tract offers a pathway chiefly to the bovine microörganism. Virulent tubercle bacilli of human origin, whether emanating from dry dust or moist droplets, will ever remain the principal source of infection. There should be, therefore, no relaxation of previous efforts to deal in a summary manner with the sputum from the diseased individuals.

It is well to review briefly the evidence upon which is founded a belief in the alimentary canal as a frequent avenue of infection. It may be added parenthetically that a provisional assumption regarding this mode of bacillary invasion is justified by virtue of the fact that other hypotheses have failed to afford a perfectly satisfactory explanation of the frequent transmission of the disease. To present in detail the numerous experiments, the conclusions derived from anatomic study, and the various theories introduced bearing upon different phases of the problem of intestinal infection manifestly is impracticable. It is sufficient to submit an outline of essential facts which have been subjected to definite substantiation. Several considerations pertaining to this subject have been discussed in previous chapters in connection with important features of infection. It has been pointed out that primary lesions of the intestine are not nearly so rare in children as has been asserted. The supposed infrequency of this condition constituted a vital argument of Koch against the transmissibility

of tuberculosis to children by means of the bovine bacillus. In like manner the unusual occurrence of primary intestinal tuberculosis was regarded as *de facto* evidence of the rarity of bacillary invasion through the digestive tract. It is now known, however, that tubercle bacilli pass readily through the intact intestinal mucous membrane. Attention has been called to the reported observations of many clinicians and pathologists, who found at autopsy upon tuberculous children primary lesions of the intestine in from 17 per cent. to 37 per cent. of the cases. Allusion has been made to the findings of numerous observers who noted the enormous frequency of tuberculous infection in the mesenteric glands of children dying of tuberculosis. Woodhead reported this condition in 100 cases out of 127. Moreover, it has been emphasized that the lymphatic glands, despite entire absence of macroscopic change, have been found in many instances infective to lower animals. The valuable experiments of Calmette and Guerin in demonstrating the penetration of bacilli through the intestinal wall without visible lesion have been described. At the end of about thirty to forty-five days following the introduction of tuberculous material through the esophageal tube the mediastinal glands were shown to be infected. The mesenteric glands, which were the first structures involved, often exhibited no macroscopic evidence of disease, although the tubercle deposit sometimes took place after a single infected meal. The inoculation of animals with these glands, as well as with apparently normal mesenteric glands, produced typical tuberculous lesions. After a continued introduction of tuberculous material with the food of animals, bacilli were found in the thoracic duct and pulmonary artery. In the chyle vessels the bacilli were engulfed by the leukocytes and conveyed to regional lymph-nodes and to the terminal capillaries in various organs, finally to become arrested and produce vascular lesions. Engel and Schlossman have performed similar experiments with like results. After administering tubercle bacilli in milk to young guinea-pigs they found, in the course of a few hours, these microörganisms in the lungs. There is permitted a strong assumption that the mesenteric glands present no barrier to the advance of the bacilli after the manner of the defensive action of other lymphatic glandular structures. On account of the unobstructed passage through these glands of fat-droplets and other elements during digestion, it has been suggested that their function is somewhat different from that of the bronchial lymph-nodes. It appears from experimental evidence that tubercle bacilli mixed with the fat penetrate the intestinal wall, pass through the mesenteric glands, and appear in the thoracic duct with almost as little difficulty as do peptones after being subjected to processes of digestion.

It has been shown that milk from tuberculous cows may contain tubercle bacilli and be capable of producing a virulent infection in children. The observations of Fibiger and Jensen have been quoted as illustrative of the added dangers of milk contamination from the existence of local lesions upon the udder. That the bovine bacillus is responsible for the development of primary intestinal tuberculosis in children in a considerable proportion of such cases has been shown by their researches. Out of seven cases of this condition observed by them, five proved to be of bovine origin, as shown by the virulent results of inoculation into calves and rabbits. They believe that infection from cow's milk is a frequent cause of primary intestinal lesions in children. Ernst

and Hirschberger have called attention to the fact that despite the absence of mammary glandular disease the milk may contain tubercle bacilli. The evidence as to the entrance of bovine bacilli into the alimentary tract of children is beyond dispute. It is obvious, however, in view of the disproportion between the large number of infants ingesting infected cow's milk and the fewer number exhibiting local lesions, that in some cases this bacillus is responsible for the origin of tuberculous processes so common in childhood in other parts of the body. No explanation is afforded for the advance of the bacillus to the glandular structures, bones, joints, and meninges, save upon the hypothesis of their entrance into the vascular and lymph-channels from the intestinal tract, and such possibility has been shown to exist. The given factors, then, in the problem of infantile infection through the digestive tract are as follows: an alarming prevalence of the disease, with local manifestations in portions of the body accessible solely through the lymphatic and vascular channels, unusual exposure to infection through the digestive canal from ingestion of bovine and human bacilli, a known passage of the microörganism through the delicate structures of the intestine, and the subsequent invasion of mesenteric and bronchial glands, and the demonstrable presence of bacilli in the lymph-vessels.

There is no occasion for a more completely sustained argument regarding the alimentary tract as an important route of invasion in children. It is recognized, of course, that infection takes place through other channels, but an analysis of clinical, pathologic, and experimental data affords positive evidence as to this port of entry. The early localization of tuberculous lesions in bones and joints among children, the frequency of glandular infection, the rarity of pulmonary or laryngeal involvement, are supplemented by the results of animal experimentation.

Whether the human or bovine bacillus is the principal agent of infection in these cases is not definitely relevant to an inquiry devoted to the channels of invasion. It must be conceded that at an early period of life especial opportunities are afforded for the entrance of both types of bacilli. It is quite impossible to attribute all cases of tuberculosis to a latent infection with the bovine bacillus acquired during infancy. The fallacy of this reasoning has been shown by the prevalence of tuberculosis in countries where cow's milk is seldom employed as an article of food for infants. Behring's theory as to the transcendent importance of the infant's milk as a carrier of infection, while unworthy of literal acceptance in its entirety, nevertheless is formulated upon certain fundamental truths and to a great extent, therefore, is entitled to a receptive consideration. The anatomic and physiologic bases for his conclusions consist of the absence, in little children, of such a digestive apparatus as will protect the system from the penetration of infective microörganisms into the body fluids. The experimental evidence which he submits in support of his doctrine of intestinal infection during infancy, as the chief underlying cause of pulmonary tuberculosis in later years, is of much interest and value. He showed that albuminous material could pass unchanged into the circulation through the intestinal membrane of young animals without undergoing digestion and conversion into peptones. The sera of diphtheria and tetanus antitoxins containing genuine albumin, after introduction into the stomach of the newly born, were demonstrated un-

changed in the blood. Adult guinea-pigs to whom anthrax bacilli free from spores were administered with the food were unaffected by the bacilli, which were evacuated from the bowels. Behring's demonstration relative to the greater ease of passage of microörganisms through the intestinal wall of infants than in adults is of much interest in connection with the vastly increased prevalence of tuberculosis in early life. It does not follow, however, that infected milk constitutes the sole means of conveyance of tubercle bacilli to the digestive tract of infants. The practice of crawling upon the floor and the instinctive habit of placing unclean hands and a wide variety of soiled articles in the mouth undoubtedly result in the introduction of sufficient bacilli of human origin to induce infection. This is particularly true in families harboring careless consumptives. Tubercle bacilli have been found to contaminate the hands of pulmonary invalids who are accustomed to caress their children, although scrupulously careful as regards kissing. Mouth-breathing and the consequent lodgment of the bacilli in the pharynx afford opportunity for their final passage into the digestive tract in the act of swallowing. Tubercle bacilli have been found in large numbers in the dirt retained under the nails of children. In addition to these obvious sources of infection an important method of bacillary invasion is the contamination, by human bacilli, of vegetable and animal food in the course of its preparation or immediately preliminary to its consumption. Infection conveyance may take place by means of the uncleanly hands of a careless cook, while in the act of coughing there also is permitted a wide dissemination over the food of finely divided though invisible particles of sputum. Exclusive of these opportunities for infection, the food is often contaminated after it has been placed upon the table, especially in places frequented by pulmonary invalids, the agitation of handkerchiefs and the sweeping of skirts upon the floor resulting in a temporary suspension of bacilli in the atmosphere. A potent cause for food infection is found in the presence of the domestic fly. The bacilli are distributed not only by the feet of the insect, but by the droppings as well. The infective material is taken into the alimentary tract of the fly, where the bacilli have been shown to multiply, and are deposited freely upon the food in the form of specks. According to Lord, as many as 5000 bacilli have been found in a single fly-speck. He computes that there may be deposited within a period of three days, from thirty infected flies, nearly 10,000,000 tubercle bacilli. The chief danger from this source results not from air contamination, but rather from the infection of food. It thus appears that even among adults the opportunities for an initial invasion through the digestive tract are by no means inconsiderable. In the light of all the evidence that has recently been brought to bear upon the elucidation of the physiologic mechanism involved in the various methods of infection, it is impossible to resist the logic of demonstrable facts, and deny the rôle of the alimentary tract as a frequently traversed pathway of bacillary invasion.

It appears almost impossible to form a definite estimate concerning the relative frequency of inhalation and deglutition tuberculosis. Although the available data are insufficient to warrant even approximate conclusions as to the usual route followed by tubercle bacilli in their entrance into the body, it may be assumed that admission is permitted through the respiratory tract less often than has been sup-

posed, and that ingress by means of the digestive canal is correspondingly more frequent. The acceptance of the respiratory and alimentary tracts as the two principal methods of bacillary invasion necessarily forces the conclusion that the selection of either route is determined by the special opportunities for infection in different instances. According to the varied conditions of exposure, the infection may take place in some cases with far greater ease by means of one method than the other. Thus children, for reasons pertaining to their food and habits, may be regarded as offering unusual facilities for the entrance of bacilli through the digestive canal, while adults, who, by reason of peculiar environment, are compelled to live in an atmosphere contaminated by tubercle bacilli, are greatly exposed to inhalation tuberculosis. In either event the important practical consideration must relate not so much to the manner of entrance into the body as to the prevention of the *distribution* of bacilli from the human and animal organism.

CHAPTER VII

DISTRIBUTION OF THE BACILLI

The living human and animal organism is not only the natural abiding-place of the tubercle bacillus, wherein are offered favorable conditions for multiplication, but is also the all-important agent of distribution.

The principal means of bovine dissemination is from the ingestion of infected milk. The eating of animal flesh is of less importance, as in most cities the carcasses are subjected to rigid inspection before the flesh is offered for public consumption, and the meat almost always is thoroughly cooked. Tubercle bacilli may sometimes be present in the milk of tuberculous cows, although there is no evidence of mammary infection, but the danger of such contamination is, of course, greater in the presence of udder lesions. Ravenel has demonstrated the possible distribution of bovine tubercle bacilli by cows in the act of coughing. The sputum was collected upon a piece of soft pine wood placed in the bottom of a nose-bag. The dissemination of bacilli in this manner is of practical significance as regards the dangers of infection to those brought into constant association with cattle and to animals confined within the same inclosure. The chief means of exit of the bacillus from the human body is through the medium of the expectoration. Irrespective of the relative frequency of infection through ingestion into the alimentary tract, or acquired through the inhalation of dried sputum dust and of moist particles expelled in coughing, the fact remains that the expectoration constitutes the vehicle for an almost ubiquitous dissemination of the microörganism. Bacilli may also be eliminated from the body with the urine, feces, or infected pus through a discharging sinus. In a surprisingly large proportion of cases the urine of consumptives is known to contain tubercle bacilli even without clinical or pathologic evidences of genito-urinary tuberculosis. Their presence in the feces to any considerable extent is conditional

upon the existence of local lesions in the gastro-intestinal tract. The actual distribution of bacilli through these excretions is greatly reduced by the comparatively small number of microörganisms thus discharged, by the sanitary disposal of the excrement, and by the destructive effect of putrefactive change. Sinus discharges containing bacilli are usually received upon suitable dressing and destroyed without opportunity for bacillary distribution other than obtains from contamination of hands or clothing. The hands of careful consumptives have been found in numerous instances to be the repository of tubercle bacilli. This is undoubtedly true to a great extent among the immediate attendants of pulmonary invalids, especially those accustomed to handle the expectoration, soiled handkerchiefs, and articles of clothing. The linen and blankets particularly are in danger of contamination, and laundresses, for this reason, are subject to more or less exposure. A luxuriant beard adorning the face of a consumptive, especially an overhanging growth upon the upper lip, represents an effective means of bacillary distribution.

Comment has been made upon the introduction of the bacillus into the mouths of children and the ease with which food may be infected by means of soiled hands and careless coughing, and upon the rôle of the house-fly as a distributing agent. Experiments to determine the existence of tubercle bacilli in places frequented by careless consumptives must be accepted as conclusive proof of their emanation from dried sputum dust. In open places exposed to sunlight their vitality is of short duration, and their presence, therefore, of slight significance. Only in densely populated communities are streets, pavements, and open public resorts likely to become contaminated to a serious extent, and then chiefly in dark alleys and courts, where frequent sprinkling or washing of streets is not permitted. The continued grinding and pulverization incident to passing vehicles, the exposure to sunlight, the moisture afforded by nature, the frequent sprinkling, flushing, and sweeping of streets, all conspire to render the actual danger from outdoor distribution of bacilli in large centers of population more fancied than real. Experiments have shown the dust to contain tubercle bacilli only in places where consumptives congregate and indulge in gross neglect of sanitary precautions. The dust from sidewalks and street-crossings is found infective to lower animals, particularly in resorts where municipal regulations pertaining to expectoration are not enforced. In view of the present administrative activity regarding street cleanliness it is probable that the practical danger of the dress-skirt as a carrier of infection from the sidewalk to the home is much exaggerated. There can be no possible doubt, however, as to the enormity of the exposure within dwelling-houses inhabited by ignorant or vicious consumptives. Aside from the contamination of clothing, bedding, handkerchiefs, beard, hands, and food, the bacilli may be deposited upon the walls or collected upon carpets or draperies. Being heavier than the air, they gravitate to the floor and settle upon carpets or rugs and in numerous dark corners or recesses. When not exposed to direct sunlight, but confined in close rooms without frequent air renewal, their vitality is continued for almost indefinite periods. When subjected to continuous agitation by drafts, rustling of skirts, sweeping and dusting of rooms, they are given unusual opportunities to acquire entrance into the human body. The ignorance of many housekeepers as to the proper method of room-cleaning is respon-

sible to some extent for the general dissemination of bacilli. The moist process of dusting and sweeping, the cleaning of rugs in the open air or by modern methods, diminishes materially the dangers arising from house infection. The investigations of Cornet, Flick, and Hance point not necessarily to the contamination of all dwellings inhabited by consumptives, but merely to the sources of danger resulting from the presence of those who are careless or ignorant. It may be assumed that the intelligent and conscientious pulmonary invalid is no menace to the family or immediate associates. The infectiousness of dust from hospital wards, street-cars, and public indoor places occupied by consumptives is usually demonstrable only when negligence of ordinary precautions has been permitted. Positive results from inoculation were obtained in one-fifth of Flick's experiments, but in no case where proper attention had been given to the reception of sputum. The investigations of Hance along similar lines resulted in negative results in dust from sixteen out of seventeen Adirondack cottages, the exception being due to a careless consumptive who had indulged in expectoration upon the walls. Gardiner inoculated the dust taken from different rooms in the largest hotel in Colorado Springs, which had been occupied by consumptives for many years, and obtained negative results in each instance.

CHAPTER VIII

PREVALENCE OF TUBERCULOSIS

Consumption is universally regarded as the most dreaded scourge of the human race. One-seventh of all deaths in civilized countries are reported to result from this disease, and, in addition, an enormous proportion of individuals harbor unconsciously latent foci of infection. The every-day experience of pathologists in the recognition of healed and unsuspected lesions is sufficient to demonstrate the wide prevalence of non-active infections and the inherent powers of individual resistance. Statistical observations concerning the frequency of tuberculous lesions found during postmortem inquiry have varied considerably, according to the thoroughness with which all parts of the body have been explored. During recent years these researches have been conducted in a more systematic manner than formerly, and reported instances of latent infection are far more numerous. Naegeli's statistics upon this subject, obtained from the critical study of 500 autopsies at Professor Ribbert's institute in Zürich, are particularly startling. After carefully inspecting every organ of the body, including the lymphatic glands, and examining a large number of microscopic sections, he reports the finding of tuberculous lesions in 97 per cent. of all the cases up to the fifteenth year, 96 per cent. to the eighteenth year, and nearly 100 per cent. up to the fortieth year. These results apparently accord with the popular German belief that every one possesses a slight focus of tuberculous infection, and tend to corroborate the old English idea that consumption was the cause of death of nearly all hard zealots in the field of letters, law, love, medicine, and religion. The discrepancy between the vast number of human

beings harboring localized lesions and those actually succumbing to the disease affords a striking commentary, as previously intimated, upon the effectiveness of self-immunization. In this connection it is only necessary to consider the many individuals who perish annually from consumption and those whose capacity as wage-earners is restricted by the disease. The number thus afflicted is truly appalling, and in nearly all countries exceeds in economic loss and human suffering all other combined agencies which contribute to the pathos of fate. When one considers the value of the working power of labor, which constitutes one of the chief commodities of the State, it is not difficult to comprehend the tremendous depreciation of economic resources entailed by the ravages of such a pestilential disease. Even without regard to the magnitude and depth of human suffering, the deprivations and blighted prospects incident to prolonged illness, the dismemberment of families, and the agony of heart and mind, the fact remains that the prevalence of consumption upon the basis of State husbandry constitutes a national, racial, and social problem comparable to which none other is worthy of consideration. The statistics concerning the frequency of tuberculosis are too familiar to justify detailed recapitulation, but a few illustrative statements taken from recent literature are of much interest.

It has been estimated that in the neighborhood of 1,500,000 people are annually incapacitated from work in the United States on account of this affliction. One hundred and fifty thousand is a low estimate of the number whose lives are terminated by tuberculosis during each year in this country. The average age at the time of death is computed to be thirty-five years, enforcing an annual preventable loss to the nation of many years of future industrial activity approximating half of man's average existence. If the value to the State of each healthy inhabitant during the entire period of usefulness is estimated at $1000, the economic loss in one year from deaths so premature must approach $500 for each individual thus removed, making an annual drain of $75,000,000 upon the United States from this source alone. This is entirely exclusive of the additional expense necessitated for the maintenance of charity organizations and institutions and the demands imposed by the disease upon private benevolence. These figures form a very conservative estimate of the potential loss each year to the United States from a cause admitted to be within the limits of prevention, and capable of producing unutterable misery. The computations of many students of political economy and observers of medical conditions far exceed those given above in an estimate of the financial loss to this country as a result of consumption. By some the amount is stated to vary from $200,000,000 to $400,000,000 annually. In these computations are included the deprivation of working capacity as bread-winners for the family, the expenditure of the savings of non-producers, the provision for children dying under twenty years, the care of those helplessly ill, and the maintenance of institutions. A commission recently appointed in Massachusetts to investigate the prevalence of pulmonary tuberculosis in that State reports upon the score of replies received from physicians and the number of consumptives within the various public institutions, that nearly 8000 individuals at present are suffering from the disease. As 675 physicians failed to give information in response to circular letters, the number of consumptives now residing in Massachusetts may be

assumed to be somewhat larger. About one-third were in the incipient stage, and an equal number in advanced and in far-advanced phthisis. Biggs states that in New York city, during the year 1902, 16,000 cases of consumption were reported to the Health Department; in 1903, 17,000; and in 1904, 19,000 cases. In 1905 nearly 32,000 cases were reported, of which over 11,000 were duplicates, and in 1906, 30,826, of which 10,741 were duplicates. He has presented much valuable data concerning tuberculosis in the city of New York from 1881 to the present time. From his statistical tables it appears that at least 10,000 people die annually from consumption in that city. It is probable that if nearly 20,000 cases of existing tuberculosis are reported to the health authorities, nearly half as many more are afflicted without the cognizance of the department. About as many people die of phthisis in Illinois annually as in the city of New York. The same is practically true of the State of Ohio. In England one-fourth of all deaths occurring during the period of useful activity are reported to result from consumption, while in Prussia this disease produces one-third of all deaths in infants. In Austria the tuberculin test has recently been employed upon healthy soldiers, with a positive result in 60 per cent. of those who were presumably well, suggesting again the remarkable distribution of latent infection. An important practical question presents itself, as to whether or not consumption is actually diminishing in prevalence as the result of intelligent systematic effort toward its restriction. Satisfying results are reported from New York city, where the reduction in the death-rate from tuberculosis is nearly one-half in the past twenty years. The percentage of deaths per 1000 population is reported by Biggs to have been 4.45 per cent. in 1884, and to have diminished gradually to 2.49 per cent. in 1903. In London it was 3.12 per cent. in 1884 and 2.34 per cent. in 1901; in Berlin, 3.6 per cent. in 1884 and 2.39 per cent. in 1902; in Vienna, 7.2 per cent. in 1884 and 4.76 per cent. in 1900; in Philadelphia, 3.32 per cent. in 1861; in 1884, 3.1 per cent.; in 1903, 2.25 per cent. In Paris, however, the death-rate is not shown to have diminished, the percentage being 5.19 per cent. in 1884 and 5.46 per cent. in 1900. In Berlin, while the total tuberculosis mortality has been reduced, the infantile death-rate from tuberculosis has been increased somewhat during the past thirty years. Statistical observation with reference to the diminished prevalence of tuberculosis in Colorado will be given in connection with geographic differences of distribution.

CHAPTER IX

INFLUENCE OF RACE

No phthisio-therapeutist of ample experience can deny the existence of essential differences among various races in the degree of resistance to pulmonary tuberculosis. An effort has been made by some statisticians to attribute the radical divergence in the mortality rate among nations to changes of environment rather than to variations of inherent susceptibility. There can be no doubt that in some instances the sur-

roundings and mode of life are responsible in large measure for the present high death-rate from consumption. This obtains particularly with reference to the negro population of the United States. It is impossible, however, to reconcile the differences in this country between the Irish, Swedes, Germans, English, Americans, and Polish Jews upon the basis of environment. It is not true that among these people there exists a remarkable dissimilarity in immediate surroundings and mode of life or in the nature of climatic influences unless it be that the Poles, who, of all nations, exhibit the very greatest resistance to consumption, suffer from the most unfavorable conditions. In America, the home of all races, it is questionable if the negro undergoes greater privation or is subjected to more unsanitary conditions than the ignorant and poverty striken Jewish emigrants from Poland, yet these two races exhibit opposite extremes in the mortality rate from tuberculosis. While the influence of environment and methods of living are readily conceded to produce salient differences in powers of individual resistance, it is none the less clear that a distinct effect is exerted by virtue of racial predisposition.

The negro race in the United States is exceedingly susceptible to tuberculosis, and environment must be admitted to play an important part. Consumption is reported almost to have been unknown upon the West coast of Africa, as well as in the interior, until the natives were brought in contact with imported cases. Though seldom before indigenous, tuberculosis once established among the colored people has been found to pursue a rapid and relentless course, presumably on account of the non-acquirement of partial immunity as a result of transmission through earlier generations. The original transplantation of the negro to the southern part of the United States was not attended immediately by such disastrous consequences in the way of tuberculous infection as might be expected from the radically changed surroundings and conditions. From a previous existence of barbarism, the slave, though brought for the first time into close association with the disease, nevertheless was permitted a life in the open air. While his lot was necessarily one of hard and useful toil, he was provided with commodious quarters and an abundance of food in a climate not sufficiently rigorous to produce suffering from exposure, nor to involve inadequate ventilation of apartments. Prior to the Civil War, consumption, while scarcely an unknown disease among the negroes, was still comparatively rare. Upon the acquirement of personal freedom there resulted inevitably such change of conditions as to produce a remarkable increase in the susceptibility of the race to the ravages of tuberculosis. This did not take place solely through the eagerness of the negro to move North and the endeavor to secure an adaptation to a more severe climate, for the disease flourished almost to the same extent among those remaining in the South and those living in New England. Of all cities in the country, however, Boston, with a colored population of 12,000, is reported to have the highest death-rate of tuberculosis among these people.

The rational explanation of an increased prevalence of the disease among the negroes is referable to the very fact of their independence. Formerly they were compelled to work in the open fields, and in most instances were comfortably housed and fed. In later years they have flocked to the large cities, congregated in great numbers in unhealthful abodes, and have sought employment, if at all, under conditions less

favorable than in the days of slavery. It is not strange that, with the sudden enforced assumption of the responsibilities of self-maintenance, for which the negro in no way was prepared by mental equipment or previous experience, he should develop to a certain extent habits of idleness, intemperance, unsanitary living, and excessive sexual indulgence, with resulting venereal taint. Syphilis. alcohol, improper food, and insufficient ventilation assuredly are potent agencies in the development of a predisposition to tuberculosis in any race. Supplementary to these detrimental influences an important causative factor is the peculiar nature of the occupation of the negro people as a class. Aside from their availability for domestic service, their illiteracy and shiftlessness limit the remaining avenues of work to drudgery in coal mines, hard labor as operatives in factories and mills, menial employment as porters in railway cars or steamships, waiters, cooks, janitors, and laundresses. All work of this nature entails a degree of confinement with unusual opportunities for infection. For the above reasons it is no wonder that the susceptibility of the negro to consumption is greater than that of all other races. Professor Jones, of the Hampton Normal and Agricultural Institution, states that the mortality rate for the colored people is from two to seven times that shown by any other race except the Irish, who exhibit two-thirds the mortality rate of the negro. The colored children, particularly under fifteen years of age, are prone to succumb to tuberculous infection, the mortality being seven times that of white children regardless of nationality. An important consideration pertaining to the problem of tuberculosis among the colored people is the exceedingly large number of negroes in the United States. The proportion to the total population is greater than that of any other alien class of Americans. They comprise 8,000,000 people, and constitute 11 per cent. of our total number of inhabitants. The high mortality rate from consumption among a class who form so large a porportion of our people invests the problem with far greater significance than relates to the prevalence of the disease among other races in our midst, who not only are decidedly less susceptible, but include a much smaller number of inhabitants. It is worthy of more than passing attention that consumption creates its greatest havoc among the very people who constitute the largest part of our alien population and who, as servants, are brought into far more intimate contact with the home life than the Irish, Germans, Scandinavians, French, Russians, or Poles.

The alarming development of tuberculosis among the American Indians presents some points of similarity to the spread of the disease among the negroes, and with equal propriety may be attributed in part to radical changes of immediate environment. To be sure, the Indians have not been forcibly imported to a new country, but they have been rudely driven from their own possessions by the encroachments of the white people, who, in conferring the questionable blessings of civilization, have been directly responsible for the decimation of the race by disease. From the available data bearing upon the subject it is fair to assume that consumption among the Indians was of extremely rare occurrence prior to their contact with European races. Since that time the disease has gradually increased until at present it has assumed the proportions of a veritable scourge. The ravages of tuberculosis are more pronounced among the Indians of the older reservations than of

the newer agencies in the Northwest, suggesting an increasing prevalence in proportion to the greater restrictions placed upon their nomadic existence. The frequency of consumption among the Indians of all tribes has been noted by the physicians appointed to care for the various agencies. Some have reported 47 per cent. of all deaths to result from this cause. Others have placed the percentage at 66, and still others at 75 and even 95. The development of tuberculosis among the Indians has been frequently cited as a conspicuous instance of the dangers of infection pure and simple. While it is, of course, true that the disease could not have been transmitted save from contact with the tubercle bacillus, other equally important factors have been introduced, strongly enforcing a predisposition to infection. In fact, the spread of pulmonary tuberculosis among the tribes occupying reservations noted for favorable climatic influences is in itself *prima facie* evidence as to the existence of a grossly unhealthful environment as well as to the practice of pernicious habits calculated to lessen vital resistance. It is known that the Indians have ever been inclined to keep singularly aloof from the white people, whom they regard with suspicion. The disease has spread among a class of beings who are kept more or less secluded in their reservations and are accustomed to an outdoor existence, in contradistinction to the negroes, who have sought indoor employment in large centers of population and have been exposed to numerous opportunities for infection. A study, however, of the present conditions obtaining in most reservations is peculiarly enlightening in explanation of the development and mortality of the disease. Dr. J. R. Walker, Agency Physician at Pine Ridge, South Dakota, has recently reported interesting data with reference to tuberculosis among the Oglala Sioux Indians. Dr. I. E. Brewer, of Fort Huachuca, Arizona, presents a review of the development of tuberculosis among the Indians of Arizona and New Mexico, embodying reports from the Colorado River Agency (Mojave Indians), the White River Agency (Apache), the Hopi Reservation (Hopi and Navajo), the Navajo Reservation (Navajo), the Fort McDowell (Apache), Pima Agency (Maricopas, Pimas, and Papagoes), the Walapai Reservation (Hovasupai and Walapai), the Mescalero Reservation (Apaches), the Santa Fé Agency (Puebloes), and the Zuni Reservation (Puebloes). While unanimity of opinion is found to exist with reference to the wide prevalence of consumption among all tribes, the reports are also uniform regarding the presence of conditions strongly predisposing to the disease. During his primitive life the Indian was habituated to an almost continuous out-of-door existence. Though compelled to endure great hardship and subjected at times to severe physical exertion, undue exposure, insufficient clothing, accustomed to improperly cooked food, and with extreme irregularity as to the time of eating, he nevertheless was comparatively free from tuberculosis on account of the invigorating influence of his open-air life. His career was essentially nomadic in character, consisting of hunting or marauding expeditions and internecine warfare. Though filthy to a degree, the evil effects were minimized by the frequent moving of camps and the construction of tepees permitting ample ventilation at the top. The disposal of slops and excrement, while unsanitary in the extreme, was non-productive of practical harm on account of the short period of accumulation. With the erection, however, of permanent houses, which were small, low, and with perfectly tight roofs, all opportunity for ventilation was prevented. Every facility likewise was offered

for the subjection of the inmates to other unhealthful conditions, including exposure to all manner of infective material. From a life in the open air the Indians were wont to congregate in large numbers in overheated rooms, with no ventilation whatever and without the slightest conception of other principles of hygienic living. Upon one of their number becoming the victim of tuberculosis, no precautions were taken to prevent the spread of the infection. Expectoration was promiscuous and usually indoors. In view of these conditions it is no wonder that the race has been threatened with extinction, but there is no suggestion of an inherent predisposition to tuberculosis as the *sole* factor in the appalling spread of the disease. In contrast with the negro, the Indian constitutes but 1 per cent. of our total population, and is brought but little in contact with the white people. The prevalence of consumption among the Indians upon the western and southwestern reservations strikingly illustrates the truism that to secure immunity from tuberculosis it is not altogether *where* one lives, but in *what manner*.

The Irish people, both at home and in other countries where they reside, have been notoriously susceptible to tuberculosis. In the United States the mortality rate is two-thirds that of the negro, being approximately 4 to 1000 of the population. This is much in excess of other nationalities in America, the Scandinavians and Bohemians having a death-rate of but little over one-half that of the Irish. According to Jones's mortality chart, the Germans, as well as French, Scotch, and Canadians, have a death-rate of one-half that of the Irish and one-third that of the negroes. The mortality rate of the English, Russians, Italians, Hungarians, and Americans from tuberculosis is still less. The rate for the Poles is least of all, being 0.625 per 1000. These statistical conclusions are closely in accord with Lillian Brandt's table of mortality of races, and conform to my own clinical observations concerning the degree of resistance shown by different nationalities in a suitable climate. A large number of patients of various races under similar conditions of climate and management were found to display remarkable differences in their ability to withstand the disease. Ten years ago I cited the disproportionate resistance shown by the Jews in comparison with the Americans, English, Germans, and Scotch, and the slighter recuperative power of the Irish and Swedes. The Irish were reported to be predisposed to a special degree, the tuberculous process being active, as a rule, and attended with early cavity formation. There was noted a marked tendency to septic and nervous disturbances, and the patients were found somewhat hard to control. This was explained in part by their volatile mercurial disposition, but lessened powers of resistance were also displayed by those not exhibiting an unstable nervous temperament and conforming implicitly to a strict disciplinary régime.

The Swedes, though apparently hardy and vigorous, were found, as a rule, to succumb much more quickly than patients of our own country. They were excessively apprehensive, impressionable to a degree, and inclined to easy discouragement, but usually obedient to instructions. The same was true to a great extent of the Bohemians, the majority of these people arriving in Colorado with extensive areas of pulmonary involvement, somewhat out of proportion to the relatively short period of illness. It has been my general experience that the Germans, English, Canadians, and even the Scotch readily adapted themselves to an appropriate system of living, excelling in this respect our

more restless Americans. There has seemed to obtain in most instances a lighter burden of business responsibilities and a more phlegmatic or philosophic disposition, with less of general restlessness or irritability. The American has often announced upon arrival that he had come to Colorado for a few proscribed months, that his recovery must take place within that period, as no further extension of time could be diverted from his business.

The clinical exhibition of resistance on the part of the Jews has been something remarkable. In spite of extensive and long-standing pulmonary disease, the nutrition and strength have been maintained to a surprising degree. I have been impressed repeatedly by the disproportion between the physical signs and the general condition. Severe mixed infection, from my observation, is much less frequent than among all other races. On the other hand, the process of *arrest* has been, as a rule, rather slow and disappointing. It would appear that the Jew possesses a certain immunity to the toxemia of tuberculosis which, despite extensive destructive change, enables him to withstand the disease for prolonged periods, but that the powers of resistance are often insufficient to produce healing of the tuberculous lesions. The tenacity with which these people retain their hold upon life in the presence of advanced pulmonary phthisis is sometimes cited as illustrative of the immunizing influence resulting from the transmission of the disease during the course of many generations. Be this as it may, the fact remains that there does exist an inherent resistance to the ravages of tuberculosis among these people. The peculiar character of the clinical manifestations among the Jews may not be justly attributed to environment alone, for in large cities the ignorant are crowded into densely populated districts and subjected to the direst poverty, the hardest of indoor work, the inhalation of vitiated atmosphere, and the habitation of apartments often noisome with filth. Attempts to explain the diminished prevalence of tuberculosis among such people upon the score of their obeyance of the Mosaic law pertaining to meat and drink is unscientific and chimerical. Even were all the meat rejected by the Rabbis assumed to come from tuberculous animals, there is no assurance that the *flesh* is thus infected, and even so, the process of cooking is known to destroy all germ life. This is not to be construed to the disparagement of municipal efforts toward rigid inspection of meats offered for public consumption. Immunity to tuberculosis among the Jews has been improperly attributed to their avoidance of pork, which is alleged to be tainted with tuberculous infection on account of the known existence of the disease among swine. It is probable that the abstinence from alcohol and the rarity of syphilis among the Jews are important factors in sustaining powers of resistance unavoidably weakened by overcrowding, insufficient food, and unhealthful surroundings. While the prevalence of consumption among these people, as with other races, is undoubtedly influenced to some extent by the conditions under which they live, it seems well established that the Jews are less responsive to unfavorable conditions that other nationalities. A study of the development of tuberculosis among the Jewish poor of New York city has been conducted by Fishberg, and of Chicago, by Sachs. The latter believes that the disease is on the increase among the Hebrews in Chicago, and that their immunity is overestimated, but ascribes an increasing prevalence to abject poverty and unsanitary conditions.

CHAPTER X

INFLUENCE OF GEOGRAPHIC POSITION

For many years the effect of climate upon the development of indigenous tuberculosis has been the subject of much professional speculation. At one time it was believed that a certain degree of immunity was established in warm regions, and patients suffering from tuberculosis were sent to localities free from low temperatures, regardless of other considerations. Later an equable climate was regarded as the chief desideratum, irrespective of moisture or sunshine. Dryness as opposed to humidity for a time was accepted as of prime importance. The character of the soil was regarded as a factor of some moment in the causation of tuberculosis, and marshy or clay ground, which retained surface moisture, was thought to be less favorable than a sandy or rocky formation. Sunshine and purity of the air, wherever found, have been espoused by some as the chief elements in promoting individual resistance. Elevated regions were thought to grant an immunizing power to consumptives, and much statistical data have been introduced in apparent substantiation of this claim. Moderate altitudes were also found to combine the maximum amount of sunshine and dryness, though lacking equability. In addition to the diathermancy exhibited in such localities, varying degrees of wind movement resulted in the dissemination of dust. Climate *per se* is believed by a few to possess no advantages whatever, the essential consideration being thought to be mere change of surroundings, all considerations of sunshine, dryness, altitude, etc., being regarded as negligible factors. Upon the basis of this reasoning the consumptive in Colorado, as Fisk aptly remarks, may be expected to achieve signal improvement by a winter's sojourn in Boston in order to secure the benefits of real change. The efficacy, even of a new environment, is repudiated by others who in recent years have memorialized the advantages of door-steps, back yards, fire-escapes, and house-tops in crowded cities. While the benefits accruing from these primitive facilities for securing rest in the open air are beyond dispute and worthy of elaboration for those unable to avail themselves of greater change, it is significant that the alleged advantages to be derived from home life are rarely taken advantage of by physicians when personally stricken with consumption. It is apparent from the contradictory opinions entertained by medical men, that no single climate grants immunity to tuberculosis, and, in fact, such is actually the case. Consumption is known to occur in all regions, whether dry or moist, high or low, warm or cold. The vital consideration in the development of the disease among people inhabiting a certain locality relates not to the climatic conditions alone, but also to the crowding of the population and the character of the general occupation. The absence of tuberculosis in new countries having sparsely settled communities and with the early settlers living in the open air offers in itself no evidence of climatic influence favoring resistance to infection. For this reason reported observations as to the infrequency of consumption in certain regions where these or similar conditions exist are practically valueless. Rational conclusions may be

derived only from reference to the climatic attributes obtaining in the populous cities of selected districts where other conditions offer a suitable basis for comparison as to the tuberculosis mortality rate. Judged by this token, the evidence is conclusive regarding the relative degree of immunity conferred through the influence of altitude combined with dryness and sunshine. The infrequency of tuberculosis in parts of Algiers, the Russian Steppes, Iceland, and Hebrides, all at low altitudes, is explained by the small number of inhabitants and the absence of crowding or industrial pursuits. In like manner the slight prevalence of the disease in the elevated regions of Africa and India may be ascribed to the same cause. Observations, however, concerning the frequency of consumption in large centers of population at low elevations in the interior, and in such cities at moderate altitudes as Denver, City of Mexico, Santa Fé, Colorado Springs, Albuquerque, and Las Vegas, are properly eligible for comparison. Gardiner has written in no uncertain tone of the remarkably low mortality rate from non-imported consumption in Colorado Springs, at an altitude of 6000 feet. The development of indigenous pulmonary tuberculosis in Denver, a city of tall buildings, large mercantile establishments, department stores, and factories, with 200,000 inhabitants, many of whom represent cases of imported consumption, has been the subject of some difference of belief among medical observers. Some years ago the opinion was promulgated by highly efficient health officers that non-imported tuberculosis was increasing at a prodigious rate. This view was indorsed to some extent by a committee appointed by the State Medical Society in 1901 to investigate and report concerning the actual status of such development. At the invitation of the El Paso County Medical Society I conducted a systematic investigation concerning the matter, and reported the results of my endeavor in an address delivered before the Society at Colorado Springs in the latter part of 1901. This was repeated by request before the Denver and Arapahoe County Medical Society in January of the following year. The questions involved are of such importance that in discussing the data concerning the development of indigenous tuberculosis in Colorado I find it advisable to utilize a portion of the material contained in my previous study of the subject.

CHAPTER XI

TO WHAT EXTENT IS CONSUMPTION INDIGENOUS IN COLORADO?

It was formerly asserted by some that pulmonary tuberculosis contracted in Colorado constituted a very important factor in mortality statistics. An indigenous disease was thought to be increasing at such a rate and assuming such proportions as to demand for its restriction drastic measures in the way of legislative and municipal supervision. Although heartily in sympathy with all rational measures of control, I have been unable to accept the evidence presented to substantiate the alleged increasing prevalence of such cases. It may be

admitted that consumption has been contracted in Colorado, as in other centers of population, and that to some extent it may be expected to originate here in the future. It is only with reference to the degree and practical significance of its development that an unprejudiced inquiry is solicited. Although consumption is communicable, it nevertheless is acquired chiefly by those rendered susceptible through environment, occupation, previous conditions, and other unfavorable influences. The infection is known to be often slow and incremental in character, prolonged exposure and in some instances repeated infection being necessary to overcome individual resistance sufficiently to produce clinical manifestations of the disease. It is to be expected, therefore, that consumption should occasionally develop in Colorado as a natural result of the massing of population, embracing all classes, from affluence to poverty, and including all degrees of predisposition. The disease should not be ascribed solely to an intimate association with imported pulmonary invalids, although there must inevitably develop frequent disregard of precautionary measures. A considerable number of the people in Colorado pursue a peculiarly unfavorable occupation, to which may be attributed to some extent the occasional development of pulmonary phthisis. Miners are subjected for prolonged periods to entire absence of sunshine and to the inhalation of an atmosphere deficient in oxygen and vitiated by dampness, dust, and smoke. Exposure to such conditions day after day cannot fail to exert a deleterious influence throughout the respiratory tract and produce a soil notoriously favorable for infection. A large portion of the younger population in Colorado are born of tuberculous parents, and in early life, when especially predisposed, subjected to continued undue exposure. As a legitimate result of these factors the origin of segregated cases of consumption is conceded, but this constitutes no argument detrimental to the value of altitude, sunshine, and dryness. The fact that the disease has not attained greater proportions is a remarkable tribute to the restraining influence of a beneficent climate. Present interest attaches to a consideration as to whether or not consumption developed in Colorado is increasing to any material extent from year to year. Upon the answer to this question depends in great measure the proper attitude of the local profession with reference to a problem extremely difficult of solution and capable of affording honest differences of opinion. It is at once evident that the situation demands a calm, judicial inquiry, the evidence presented to consist of a cold analysis of statistical facts and not dogmatic opinions or preconceived ideas.

During the past fifteen years public attention has been repeatedly drawn to an alleged rapid increase in the number of deaths from consumption contracted in Colorado.

A review of the material offered as evidence to establish the large proportion of cases originating in this State to those contracted elsewhere indicates that the chief source of information is found in the former records of the Denver Health Department. In the annual report for 1896 it was stated that the number of deaths during the previous year from tuberculosis developed in Colorado "is a little more than one-sixth of the total tuberculous death-rate." It was noted also that the percentage of deaths from tuberculosis contracted in this State had been progressively increasing. In 1893 the proportion was stated to be 11.25 per cent.; in 1894, 13.7 per cent.; in 1895, 15 per cent.; in 1896, 18.4 per cent. Later

reports from the Health Department showed the proportion in 1897 to be 18 per cent., and in 1898, 19.7 per cent. The source of information upon which these statistics were compiled was the returns upon the death-certificates.

The percentage of *deaths* is by no means a fair criterion of the *proportion* in Denver of cases said to have developed in Colorado to those contracted elsewhere. The pulmonary invalid from a distance, with a hopeless prognosis, is usually advised to return home. Comparatively few such patients, fortunately, are permitted to die in Denver, removed from family and friends. The proportion, then, of one to six does not properly apply, as might be inferred, to the existing cases of tuberculosis in Colorado.

It is easy to demonstrate the fallacy of an alleged rapid increase in the percentage of deaths from tuberculosis contracted here. It is apparent that a given ratio may be radically transformed by a change in either of its terms. In other words, the percentage of deaths from tuberculosis developed in Colorado may be increased from year to year by reason of an increase in the number of such deaths, provided the total tuberculous death-rate remains unchanged. Upon the other hand, if the entire death-rate from tuberculosis is diminished, the *proportion* of indigenous cases may be *increased*, although the actual *number* be less than in previous years.

While the figures of the Health Department previously cited show the percentage to have increased very rapidly, the actual number of cases originating in Colorado was but slightly larger for the four years, while the total number of deaths from tuberculosis was considerably less; this, of course, effecting an increase in the *proportion*, but possessing no further significance. Thus in 1893 the total number of deaths from tuberculosis was reported as 435, of which 49 were specified as contracted in Colorado, establishing a percentage of 11.25. The next year the total number was 377, a diminution of 58, while the number contracted in Colorado was 51, an increase of but two cases for the entire year. It is obvious at once that the increase is entirely insignificant, yet the proportion is published as being 13.7 per cent., a gain of 2.5 per cent. in the deaths originating in Colorado for the year.

An analysis of the statistics for 1895 and 1896 gives practically the same results. The number of deaths in 1896 is but two more than for 1895, and but 17 more than for 1893, in spite of an increase in that time of 26,000 in the population, yet the percentage is much increased in 1896 on account of a diminution of 60 in the total tuberculous death-rate.

It is of much interest to note that the statistics for 1899, furnished by the Health Commissioner, were decidedly at variance with those previously reported, and serve to some extent as an official refutation of the asserted rapid increase of pulmonary tuberculosis in Colorado. Despite a material increase in the population of Denver since 1893, the number of cases specified as having developed in 1899 was but four more than in 1893, and the percentage of such cases to the total deaths from tuberculosis was but 9.9, about one-half that reported for the three previous years, and less than any proportion which has been determined since 1893. The compilation of these statistics was based upon the same official sources of information as in the previous years.

In the summer of 1901 the mortality statistics of consumption were reviewed upon the basis of the returns collected by the State Board of

Health rather than the Denver Health Department, during the sixteen months included between January, 1900, and May, 1901. An investigation conducted by different officials through the channels of another department and perhaps in accordance with other methods might be expected to disclose a difference in final results entailing a possible modification of previous conclusions. It is interesting to learn, therefore, that the proportion of deaths from consumption developed in the State to the total tuberculous death-rate for the sixteen months during which the statistics were collaborated was stated to be 13.32 per cent. This chanced to be the same proportion as was published by the Denver Health Department for 1894, and failed to indicate on the face of the returns any increase whatever in such deaths during a period of seven years. As a matter of fact, the proportion was about one-third less than that reported for 1897 and 1898.

Unfortunately, from 1901 to 1904 the Health Commissioner of the city of Denver preserved no record pertaining to cases of pulmonary tuberculosis contracted in Colorado. After diligent search it has been impossible to discover any data upon which to compile statistics of this nature during his tenure of office.

According to the official annual report of the statement of deaths for the city and county of Denver by the Health Department in 1905, there were 39 cases of pulmonary tuberculosis stated to have developed within the State, as compared with a total mortality rate from tuberculosis of 661, establishing a proportion of only 5.9 per cent., which is less than any year since the compilation of such statistics in 1893. In 1906, however, an increase was noted over the preceding year, there being 58 cases reported to have developed within the State as compared with a total death-rate from this disease of 634, making the percentage 9.1, which chances to be smaller than in 1893, or any succeeding year up to 1905.

Another aspect of the subject is the significance of an annual increase in the population, which was not formerly considered in the official computation of vital statistics in the State. While possibilities of error necessarily attend any effort to determine the relations of indigenous consumption, perhaps no method is as satisfactory in affording approximate conclusions as the proportion of such cases to the population. Accepting the figures of the Health Department relative to the population of Denver and the number of deaths annually from primary tuberculosis since 1893 as an eminently fair basis for analysis, the percentage of such deaths per 1000 inhabitants was found to vary but little from year to year, the proportion being less in 1894 than in 1893; in 1896, slightly less than in 1895, and in 1899, three per 10,000 people as compared with three and a fraction in 1893. Apropos of these results, attention is directed to the report of the Committee upon Tuberculosis, which stated that for the first eleven months of 1900, the only time during which statistics were compiled, the percentage of such deaths to the present population was three persons per 10,000 people. This coincided singularly with my analysis of death reports for previous years, being practically identical with results obtained for 1899 and 1893, being even less than in 1894, and presenting but trifling fluctuation in succeeding years. From this comparison it was seen that the Committee's report failed to demonstrate the slightest increase of indigenous consumption from the time the agitation received its inspiration.

As previously stated, there are no available statistics pertaining to this subject during 1901, 1902, 1903, and 1904.

The proportion of deaths from indigenous tuberculosis in 1905, according to the official report of the Denver Health Department, is less than two per 10,000 people; in 1906, a little over two for 10,000 people, in both years being less than any percentage previously obtained.

Still another phase of the subject is the relation of infantile tuberculosis mortality to the total deaths from consumption contracted in Colorado. An analysis of data obtained from the Denver Health Department showed that, of all persons reported to have died of tuberculosis originating within the State during a period of seven years, up to 1900, nearly one-fourth were children under four and five years of age, of whom 85 per cent. died of tuberculous meningitis. During the following year, out of a series of 76 cases, concerning which special detailed information was obtained, 27, or over one-third of the entire number, were under five years of age. Manifestly, in view of the special predisposition, such infantile cases, without qualifying explanation, should not be included as instances of death from indigenous pulmonary tuberculosis.

A similar consideration deserving mention is that of occupation. It is found, by reference to the report of the Tuberculosis Committee, that out of a total of 224 cases 49, or more than one-fifth, occurred among miners. The vast importance attaching to so large a proportion among this class, modifying as it does any superficial conclusions, is appreciated when one considers that the tuberculous element is subordinate to other pathologic changes, and occurs as a mere final development. It is suggested that these patients scarcely ever associate with consumptives, but exhibit a constant disregard of general hygienic laws which involve subsequent tissue changes insuring a favorable soil. Obviously, these cases should not be instanced as examples of the dangers of every-day infection.

As bearing directly upon this line of thought, the attention of the student is directed to the location, in the State, of reported indigenous cases. El Paso County, containing a greater relative proportion of consumptives than any other, and, therefore, likely to yield the largest percentage, presents the remarkably small number of six cases, or about $\frac{1}{27}$ of the whole. Gilpin County, with a much smaller population, among whom consumptives are exceedingly infrequent, the people being comprised largely of miners, offers a percentage nearly three times as great.

A factor of no inconsiderable importance, to which attention was called by me in 1897, is the entire absence of proof that cases reported as developing in Colorado were actually contracted here. It was contended that the mere fact of an individual exhibiting physical signs of tuberculosis less than one year after arrival is no evidence of its having originated in Colorado.

The arbitrary inclusion of such cases unavoidably implies a non-acceptance of the theory of a latent tuberculous process, and is opposed to the incontrovertible testimony adduced in recent years as to the extraordinary frequency of unsuspected tuberculous infection. Many Colorado physicians, from their daily experience, can testify concerning individuals apparently sound, with clear eye, bronzed cheek, and well-rounded proportions, yet victims of an incipient, if not active, infection. Is it not probable, among the large number of people coming

to this State accompanying invalid relatives and friends, with individual resistance subsequently diminished through hardships undergone and privations endured, that some have developed an active process from an infection previously latent? If this be true, it may be asked, by virtue of what right should it be assumed that the development of the disease in apparently healthy people is sufficient ground to assert its origin in Colorado, without recourse to investigation and without at least a residence in the State of one or more years?

I am unable to understand how a reasonable interpretation of official data justifies a conclusion as to an alarming increase of indigenous cases. If consumption contracted in Colorado is actually increasing to any extent year by year, it remains to be demonstrated by statistical observations not as yet introduced.

Let it be understood that no negative testimony is presented in rebuttal of the positive claims of those with whom I have been forced to differ. The position originally assumed was taken solely from the analysis of their own recorded official statistics, the authenticity of which has never been disputed. It is admitted that clinical reports from conservative and painstaking observers furnish testimony from time to time concerning the occasional existence of indigenous cases. That a more interested attention is being devoted to the investigation and report of such cases is certainly a source of congratulation and gives promise of perhaps more definite future knowledge. From information thus far received, however, it would appear that in a large proportion of the cases reported, there had been abundant reason for the development of the disease by virtue of a marked inherited taint, the presence of some recognized predisposing cause, occupation, or special exposure. This is illustrated somewhat by my own experience, which comprises a list of 35 cases out of a series of 2070 cases seen in private practice during a period of sixteen years. In 9, occupation may be justly considered to bear an important relation to the etiology, 3 being old miners, 3 stone-cutters, 1 a layer of carpets, 1 employed in a steam laundry, and 1 a cigar-maker. With 2 a very reasonable doubt may be entertained as to the origin of the disease in Colorado, 1 having developed it six months after arrival and the other having been in Sweden upon a long visit immediately before the disease manifested itself in this State. With 6 others there was a distinct history of great exposure to infection, such as would endanger health in any climate. Another is an instance of pulmonary tuberculosis occurring in a child whose mother died of consumption three weeks after he was born. The remaining cases are offered as examples of tuberculosis contracted in spite of a favorable climate, for which no explanation is made. One of these developed tuberculosis complicating a long-standing diabetes, another in association with chronic interstitial nephritis, 2 in conjunction with pronounced habits of dissipation, and 4 following severe influenza. No mention is made of the several cases of tuberculous meningitis occurring during the first one or two years of life in infants born of tuberculous parents, as these do not appear to come within the scope of this inquiry.

Although deprecating all sensationalism that tends to inspire alarm, there is advocated no abatement of the hearty support to be accorded to health authorities, nor of earnest and combined efforts along the lines of preventive medicine. Measures necessary for the restriction of consumption should be enforced in Colorado, as in other States.

CHAPTER XII

GENERAL CONDITIONS INFLUENCING INFECTION AFTER EXPOSURE TO THE TUBERCLE BACILLUS

An *inherited predisposition* to consumption is commonly regarded as a feature of the utmost importance, although modern opinion concerning the etiologic significance of the family history is quite divergent. A mass of statistics has been cited by various observers to demonstrate and also to refute the influence of heredity in the development of the disease, and it almost appears that both the affirmative and the negative contention may be substantiated by analytic inquiry. Statistics concerning this phase of pulmonary tuberculosis are usually collaborated with reference solely to tuberculosis in the immediate antecedents, irrespective of such other features as the time of its development, its duration, the degree of association permitted with other members of the family, the environment, and the opportunities for infection. These factors, if investigated properly, often clothe the compiled results with far greater importance. Without elaborate inquiry along collateral lines, analytic reports concerning an inherited predisposition are devoid of special practical interest.

The vital consideration relates not to the fact that one or more members of the family died of consumption, but chiefly to the time, conditions, and circumstances under which the disease existed. Children whose parents subsequently became tuberculous belong to an entirely different category from those whose progenitors were consumptives at the time of conception. The opportunities for postnatal infection are frequently sufficient to prevent an assumption concerning the precise influence of an inherited predisposition. The tubercle bacillus is present to a particularly dangerous extent in houses inhabited by pulmonary invalids, and at no age is greater opportunity afforded for acquirement of the infection than during infancy. In the majority of cases the essential element in the propagation of the disease among children is not the inheritance of a tuberculous taint or predisposition from infected parents, but rather an undue vulnerability of tissues peculiar to infants and an excessive exposure to sources of acquired infection. These conclusions appear justified by the results of clinical experience in a health resort extensively frequented by pulmonary invalids. In several instances I have seen children of perfectly healthy parents succumb to tuberculous infection, explainable upon inquiry by contact with a pulmonary invalid. On the other hand, children of tuberculous parents have often been observed to thrive to a remarkable degree upon enforcement of rigid precautionary measures. I have in mind a child of two and a half years both of whose parents are tuberculous. The infant at birth weighed less than four pounds, was a typical "blue baby," and lost nearly one pound during the first two weeks of life. The evidences of physical debility were pronounced, malnutrition persisting for a long time. Though reared exclusively upon modified milk, the infant finally attained a surprising degree of nutrition and vigor. To minimize opportunities for postnatal infection the child has been kept under the successful management of a nurse in an isolated portion of the house.

There is to be expected, of course, a diminished resistance in children born of parents with waning strength and vigor as a result of pulmonary tuberculosis, carcinoma, nephritis, syphilis, severe nervous disturbances, and old age. This impaired vitality, unless incident to infantile syphilis, bears no inherent relation to the specific nature of the parental constitutional condition. It does not characterize tuberculosis alone, and is due not to the cause of the parental weakness, but to the debility itself. The offspring displays a lessened resistance to disease in general, with no greater predisposition to tuberculosis than to some other affection only in so far as its wide prevalence furnishes greater opportunities for acquired infection. It has been shown that children with lessened powers of inherent resistance to disease nevertheless may thrive by virtue of especially favorable conditions.

The relation of *environment* to infection is of considerable interest.

It is somewhat doubtful to what extent an increased vulnerability of the tissues to tuberculous infection may result from external causes. It is quite impossible to state the relative importance of lowered resistance and direct exposure as causative factors in the development of the disease. It has been the tendency in recent years to ascribe the spread of tuberculosis more directly to the distribution of the bacillus, and preventive measures, therefore, have been directed almost exclusively toward its destruction. Through the influence of societies for the prevention of tuberculosis and the administrative efforts of municipal and State health authorities the attention of the profession has been called to the necessity of removing all possible sources of bacillary infection. Commendable as has been this work along the lines of preventive medicine, it is apparent that there exists to some extent an unconscious inclination to overlook the etiologic significance of conditions pertaining to the every-day life. It may be assumed that the factor of paramount importance in the production of tuberculosis is the presence of the tubercle bacillus, and that efforts toward its removal will be attended with a gratifying diminution in the prevalence of the disease. It may be asserted, however, with equal positiveness, that the possibility of bacillary invasion, its degree and result, are greatly modified by the receptivity of the soil. The activity of the tuberculous infection is extremely variable in different people subjected to precisely the same conditions. Among several members of a family suffering equal degrees of exposure the development of the disease may be observed in but a single instance, or, if in more than one, with the virulence of the infection strikingly dissimilar. This distinguishing difference in individual receptivity is observed in prisons, reformatories, barracks, and even among the attendants of consumptives in sanatoria. For a long time it has been recognized as a clinical truism that races and families manifest a remarkable difference in the degree of susceptibility to infection and in the power of subsequent resistance. If such conditions are found beyond question to exist with reference to families and nations, it is reasonable to expect corresponding individual variations in the types of infection. Important controlling factors relate to the methods of living, the habits, occupation, and social conditions. Exceeding importance attaches to the existence of hygienic surroundings, adequate ventilation, sufficient food, proper clothing, the absence of excesses, and the avoidance of oppressive cares and burdensome vexations.

Consumption has been found to afflict the poor oftener than the well-to-do, the ignorant more than the educated, the vicious and intemperate rather than the refined and gentle, and those who are mentally depressed and despondent rather than the cheerful and sunny in disposition. The disease exhibits a proneness to select as victims hard students, individuals accustomed to sedentary pursuits, those who follow certain unfavorable occupations, and, finally, persons subjected to arbitrary confinement in prisons and other detention institutions. The undue preponderance of consumption among these people and amid such conditions is, to say the least, strongly suggestive of a predisposing influence. The development of the disease among athletes and individuals apparently in the very prime of health and vigor constitutes no argument in opposition to the etiologic significance of a suitable soil. While such instances occasionally attain a conspicuous prominence, they are, upon the whole, quite exceptional. The inference is strong that in athletes accustomed to heroic feats of overexertion there may exist a certain pathologic disturbance of normal conditions materially favoring the development of tuberculosis. Certain it is, as a matter of clinical experience, that an infection once established in such cases is almost sure to pursue an unfavorable course. It has been my observation that no class of patients exhibits less power of resistance to the ravages of consumption than the athlete or hard-working farmer. In like manner the prevalence of pulmonary tuberculosis among the inmates of prisons and reformatories has been frequently cited as an overwhelming example of the danger of transmitting the disease from one person to another. It is apparent that there is a tendency to disregard the predisposing influence of confinement, lack of sunshine, fresh air, exercise, proper food, contentment, high ideals, and incentives to work. It is interesting to note, from a review of statistics, that the propagation of the disease in prisons is not noticed as much among those who are allowed a portion of their liberty as among those subjected to solitary confinement or imprisoned for a part of the day within the confines of a narrow cell. It would appear that if, regardless of environment, the presence of the bacillus was the sole consideration, the greatest development of consumption, on account of the exceptional opportunities for infection through personal contact, should take place among convicts who are permitted to mingle more or less in crowded workshops. The fact that the spread of the disease in these institutions relates particularly to those who, through their segregation, are less exposed to the dangers of infection, adds corroborative evidence as to the predisposing influence of an unfavorable environment.

Attention has been called to the fact that, prior to 1864, consumption was comparatively rare among the negroes, partly because of the few sources of infection, but more particularly because of their outdoor existence, obligatory physical exercise, abundance of suitable food, and the general contentment and peace of mind incident to life in the quarters. Upon being compelled to care for themselves, for which they were very imperfectly adapted by previous training, there was imposed a necessary assumption of oppressive responsibilities. The country air was changed in many instances to the less pure atmosphere of large cities, and was often foully contaminated by their crowding together in small apartments. In the absence of enforced work in the open air there developed unavoidably a tendency toward shiftlessness

and dissipation. As a result of insufficient food, inadequate clothing, occasional undue exposure, imperfect ventilation, and habits of alcoholic and sexual intemperance and disease, there has resulted a pronounced acquired disposition to tuberculosis, which, added to the vastly greater sources of infection, has operated toward the decimation of the race.

It is true that consumption among the American Indians was unknown while they were permitted to roam at will throughout their natural domain. The later ravages of the disease may not be construed as resulting entirely from the numerous sources of infection incident to civilized life, but are dependent to some extent upon the complete transformation in the life, habits, and environment of the Indian himself. As a matter of fact, consumption upon the frontier among the white people is extremely rare, and the opportunities for infection are not so numerous as at first might be supposed. Assuredly they are not sufficient to explain alone the somewhat remarkable spread of the disease among the Indian race. As with the negro, at least a partial explanation is found in the lessened outdoor existence, diminished exercise, infrequent hunting diversions, marches, and marauding expeditions, the greater restrictions upon their liberty, and the inculcation of habits of shiftlessness and dissipation.

Still another instance of the influence of environment as a predisposing factor in the development of tuberculosis is found in the somewhat surprising development of the disease among soldiers who are subjected to rigid physical examinations before admission to the armies of the world. In a report recently issued concerning the health statistics of the United States army for the past calendar year it is stated that, in spite of the short term of enlistment and their assumed normal condition upon entrance to the army, 0.68 per cent. of the soldiers succumbed to tuberculosis, while 5 per cent. of all the deaths in the Philippines and 20 per cent. of the discharges were occasioned by this disease. These facts are not to be attributed entirely to the confinement incident to the barracks and the consequent opportunities for infection. An additional causal factor is found in the unpleasant environment, as evidenced by the frequent desertions, the irregularities in the quantity or quality of food and the time of its administration, and the fatigue, discomfort, and exposure resulting from camp life and strenuous marches.

That *occupation* is an element of some importance in the causation of consumption is shown by the alarming prevalence of the disease among employes in department stores, mills, post-offices, printing-rooms, and saloons, in all of which places the ventilation is notoriously inadequate. The influence of occupation is still further emphasized by the development of tuberculosis among millers, plasterers, stone-cutters, grinders, potters, and other persons necessarily obliged to breathe an atmosphere deficient in oxygen, contaminated by noxious vapors, or impregnated by particles of impalpable dust.

The influence of *age* and *race* has been discussed in previous chapters. *Certain diseases* are known to effect a varying degree of predisposition to tuberculosis, as measles, whooping-cough, bronchitis, influenza, and typhoid. It is probable that in most instances the tubercle deposit previously existed as a latent infection, a renewed activity being induced on account of the lessened resistance incident to the recent illness. The

relation of the above diseases and of pneumonia, pleurisy, pulmonary hemorrhages, and trauma to tuberculosis are more properly suited for discussion in other portions of the book.

In addition to such individual peculiarities as age, inheritance, occupation, environment, and previous diseases, all of which are known to influence infection to some extent, the *relative virulence* of the *bacilli* and the *character* of the *tissues* are known to aid in determining the course of the disease. Variations in the virulence of tubercle bacilli are known to exist, and it is highly probable that essential differences in the clinical manifestations and in the nature of pathologic changes result from this cause. Another factor of considerable importance in influencing infection is the number of bacilli succeeding in gaining entrance into the body. In other words, the resulting clinical and pathologic change may be expected to correspond more or less to the dose of the infection, if such a term be permitted, the combined effects of many bacilli being far more difficult to overcome than a small number. The receptivity of the soil in the particular portion of the body destined to be the accidental abode of the bacillus is still another feature of moment in the determination of the resulting infection. Growth and distribution are favored particularly in vascular tissues rich in lymphatics and with an excess of moisture. Looseness of texture represents conditions eminently suited to the development and spread of tuberculosis as opposed to dense structures poorly supplied with lymphatics. It is thus inexpedient to attribute the entire responsibility for the character of resulting infection to the *individual* upon the score of increased susceptibility, when manifestly the entire subsequent course of the disease may be dependent upon such accidental conditions as just described. As previously stated, it is possible that the clinical exhibition of supposed differences in vital resistance may be partly explained by variations in the virulence of the invading microörganism. It is notorious that anemic, poorly nourished, and apparently enfeebled individuals often succeed in effectually overcoming tuberculous infection, while others in seeming health and vigor, with an apparent surplus of resisting power, rapidly succumb to infection.

SECTION II

PATHOLOGIC ANATOMY

CHAPTER XIII

GENERAL CONSIDERATIONS

THE morbid processes peculiar to tuberculosis may affect various organs of the body. In adults the lungs are the parts generally involved, while in children the lymphatic glands, bones, and joints are frequent seats of the disease. The pathologic conditions in tuberculosis of the meninges, pleura, serous membranes, lymphatic glands, bones, joints,

intestines, and genito-urinary apparatus will be discussed in connection with tuberculosis of these special regions. Present discussion relates solely to a consideration of the various anatomic changes found in tuberculosis of the lungs.

In pulmonary tuberculosis there exists a striking variety of pathologic conditions. The essential morbid processes are: (1) The development of minute nodules conforming to a fixed type of structural change, and known as the true pathologic tubercle; (2) the degenerative change peculiar to the tubercle itself, including caseation and softening; (3) the constructive processes within and around the tubercle; (4) conglomerate tubercle formation; (5) diffuse tuberculous infiltration without the development of discrete nodules; (6) secondary inflammatory processes attended by their various exudates. These latter infections, with their lesions, not infrequently constitute the most conspicuous gross anatomic change, the nodules appearing upon macroscopic inspection relatively inconsequential. In some cases definite tubercles are absent altogether, fulminating pneumonic processes with speedy destructive change predominating over the more characteristic tubercle. Again, in other cases, the secondary inflammatory condition is accompanied by extensive reactive processes of connective-tissue repair, the exudative and degenerative lesions being comparatively inconspicuous. In this way the natural constructive efforts are analogous to the sclerosis taking place in the peripheral region of the tubercle itself. Thus it is seen that the pathologic condition in the lungs of different individuals suffering from pulmonary tuberculosis or in various portions of the same organ conforms to no single anatomic type. According to the extent and character of the morbid process in the pulmonary tissues there may result in several parts of the same lung striking differences in the microscopic and macroscopic appearance. The only lesion which may be regarded as definitely characteristic of tuberculosis is the elementary tubercle, and even this, without the presence of bacilli, fails to serve as an absolutely distinguishing feature of the disease. Similar tubercle formation may be present in syphilis, and is sometimes produced by other microörganisms. It is even claimed that pseudotuberculosis may result from the irritation of certain foreign bodies. It is probable, however, that in nearly all instances the histologic changes are produced by bacteria, and that by far the most common microörganism in such formation is the tubercle bacillus. While in tuberculosis the true pathologic tubercle constitutes a characteristic lesion, the presence of bacilli in the tissues forms an essential condition. Further, a genuine tubercle deposit may exist in various portions of the body without the affected tissues exhibiting the definite histologic structure of elementary tubercle, as commonly observed in lupus vulgaris. Again, the tubercle itself not only may undergo certain evolutionary changes either degenerative or constructive, but even in the acme of its development may exhibit important differences in structural formation, as will be described later.

Until quite recently it has been the general belief of pathologists that the mode of entrance of the bacillus into the pulmonary tissues has been chiefly by inhalation into the bronchial tract. In miliary tuberculosis a general distribution of the bacilli to the lungs through the medium of the circulation has been recognized for a long time. While conveyance of the infective agent to the pulmonary tissues by

means of the lymphatic current was known to take place in occasional instances, immediate infection of the lungs from aspiration of the bacilli has been regarded as the much more common method. In the light of modern investigation, to which reference has been made in preceding chapters, it is probable that the principal method of bacillary distribution is through the lymphatic and vascular channels. It is known that bacilli may traverse the mucous membranes and enter the circulation without primary lesion at the point of entrance. Attention has been called to the rapid tuberculous involvement of mesenteric and bronchial glands following the penetration of an intact intestinal membrane. Shortly after test-meals of infective food, bacilli have been detected in the thoracic duct and even in the pulmonary artery. It cannot be denied that bacilli may enter the alveolar tissues *via* the respiratory tract, the blood-vessels, and the lymphatic circulation. In pulmonary tuberculosis, irrespective of the precise mode of infection, it is extremely difficult to discriminate between the ultimate morbid conditions presented in different instances. Therefore, it is obviously inexpedient to attempt a description of the pathologic findings based upon the several methods of invasion. The old belief that the bacilli are almost always inhaled directly into the alveoli to set up limited areas of tuberculous pneumonia, or to pass between intact epithelial cells producing tubercle formation in the peri-alveolar and peribronchial connective tissue, is entitled to less credence than formerly. The common location of elementary tubercles in the immediate vicinity of the arterial terminals makes it probable that primary localized lesions take place in the intima of the finer arterioles more frequently than has been supposed. Scattered tubercle deposit in the pulmonary tissues is often recognized in immediate proximity to preëxisting glandular foci of infection, the lymphatics being the obvious carriers of the bacilli. In view of the relative infrequency at autopsy of pulmonary lesions without involvement of bronchial glands and the greater frequency of tuberculosis of the lymph-nodes without pulmonary infection, it is fair to assume that these constitute an important reservoir for the subsequent distribution of the bacilli. Finally, on account of the early merging of the pathologic conditions, regardless of the method of entrance, into a single lesion, *i. e.*, the elementary tubercle with accompanying inflammatory changes, it is unnecessary to emphasize further the so-called bronchogenic, hematogenic, or lymphogenic methods of infection.

CHAPTER XIV

HISTOLOGY

The structure of the primitive tubercle or nodule from which the disease derives its name is of special interest. Generally speaking, tuberculosis begins with the formation of a miliary tubercle, which is the result of mild inflammatory processes, in turn produced by the irritating presence of the bacillus in the tissues. This subsequently undergoes varying degrees of degenerative change. The miliary tubercle, though

deriving its name from its resemblance in size to the millet-seed, nevertheless presents considerable variation in this respect. The size may vary from $\frac{1}{10}$ to 3 millimeters in diameter, in some cases approaching the dimensions of a small pea. It is usually a compound body, composed of a number of smaller elementary tubercles which are sometimes termed "submiliary." From ten to fifty or more of these smaller tubercles may unite to form a single miliary tubercle. The term "submiliary" is often applied to large tuberculous masses formed by the coalescence of many miliary tubercles, but it would seem that the more proper descriptive adjective for such confluence of tubercles would be "conglomerate," rather than "submiliary."

The true elementary tubercle is a small, non-vascular, translucent nodule, containing tubercle bacilli and usually characterized by giant-cells, epithelioid cells, and lymphoid cells contained within a reticulum of fibrous tissue. The tubercle bacillus is almost the sole irritative influence capable of producing this characteristic cellular proliferation. The series of events leading to this tubercle formation is undoubtedly more complex than is at once apparent. It is believed that when the bacilli first obtain lodgment in a favorable nidus for growth and development, they are rendered somewhat inert by a protective envelope which is later removed, permitting multiplication of bacilli and proliferation of cells. The latter increases in proportion to the multiplication and irritating effect of the bacilli. The multiplication, in turn, is checked to a certain extent by the excessive cell division which it has succeeded in stimulating. The bacilli continue to multiply and the cells to increase up to the point of such peripheral connective-tissue formation as suffices to produce a protective and inclusive barrier, within which some of the bacilli are destroyed by the phagocytic cells. The cellular proliferation may be essentially epithelioidal or lymphoidal, according as the cells are derived from the connective tissues or result from an infiltration of leukocytes from surrounding blood-vessels. The inflow of wandering leukocytes responds to the local irritative effect of the bacilli upon the vascular system, and as this influence predominates, the cellular infiltration is proportionately lymphoidal. As a rule, however, the *early* reactive influence upon the tissues as a result of the local irritation, is a proliferation of the fixed connective-tissue cells and the endothelial cells of the blood- and the lymph-vessels. Both the epithelioid and lymphoid cells are, as a rule, mononuclear, in contradistinction to the giant-cells which later appear. The nuclei of the epithelioid cells stain but faintly, while the nuclei of the round-cells stain much more deeply and have a smaller protoplasmic body. While in some instances the epithelioid cells may predominate and in others the lymphoid, it commonly happens that the former cells are more within the tubercle structure and the latter in the peripheral parts. The giant-cells form an important characteristic of tubercle formation, and are known to occur in other conditions than tuberculosis, notably in the granulomata and in sarcoma. They are large, oval, or circular protoplasmic masses containing multiple nuclei. These are sometimes grouped at the two extremities of an oval cell constituting the so-called bipolar arrangement of nuclei, and are often disposed circularly within the giant-cell around its outer margin. Several theories have been offered in explanation of the formation of giant-cells. According to Councilman, they may result from the coalescence of several epithelioid

cells, or from division of nuclei without division of the protoplasm, or from proliferation around a thrombus of endothelial cells of the blood or lymphatic vessels. Metchnikoff believes in their origin from a fusion of epithelioid cells, while Baumgarten adheres to the belief of their development from multiple division of the nucleus of a fixed tissue-cell. The giant-cells, which are considered by Metchnikoff to be active agents of defense, often vary considerably in number in inverse ratio to the bacilli. It is recognized that in tuberculosis of lymphatic glands, of bones and joints, and in lupus, the giant-cells are numerous, whereas the bacilli are few. In miliary tubercles, however, the reverse is the case. Bacilli may be present in the giant-cells as well as in the epithelioid and lymphoid cells, or between the various cells in the periphery of the tubercle. They are often found in the center of the tubercle which is undergoing degenerative change. It has been noted that when present in giant-cells

Fig. 1.—Drawing of miliary tubercle of the spleen, from case of miliary tuberculosis. Note central area of beginning necrosis and connective-tissue reticulum. Note the two giant-cells, the one in the center showing distinctly peripheral arrangement of the nuclei. Note further peripheral infiltration of the round-cells.

they are apt to congregate in the center in the event of a peripheral or mural arrangement of nuclei, and in case of elongated cells with nuclei at one pole, to assemble at the opposite extremity. With advancing degeneration in the center of the tubercle the bacilli in this region disappear as a result of disintegration and death, the number increasing, however, in peripheral portions.

An important constituent of the elementary tubercle is a reticulum of connective tissue, which is interwoven between the epithelioid and lymphoid cells, and sometimes appears to be a branching extension of the protoplasmic areas characterizing irregular giant-cells. The connective-tissue reticulum is much more abundant at the periphery of the tubercle. The reticulum is thought to be formed in part by the fibrination of the protoplasm of cells.

Degenerative change is characteristic of tubercle deposit and sometimes takes place early in the evolution of the lesion. Owing to the absence of newly formed blood-vessels, no nutriment is conveyed to the tissues within the tubercle. The avascular condition is an important cause of the degenerative change. Other factors responsible for its production are the specific effect of the living tubercle bacillus and the toxins. The degenerative processes consist of hyaline change, coagulation necrosis, a degree of fatty degeneration, varying degrees of caseation, and calcification. The degenerative changes usually take place early in the central cells of the tubercle, sometimes affecting the giant-cells before all others. Usually the lymphoid cells are transformed somewhat before the degenerative process attacks those of the epithelioid variety, which apparently are more resistant than other cells. Owing to the excess of lymphoid cells the epithelioid type is often not recognized until the former have degenerated and disappeared. Definite caseation is preceded by a slight granular change in the protoplasm of the cells. With later degeneration the nuclei are found more or less broken down and fragmentary, with lessened inclination to take ordinary stains. Some authors, however, have noted a bright staining reaction of the nuclei even in the midst of necrotic change. The contour of the cells becomes defined less sharply until the outlines are lost altogether, the affected portion of the tubercle consisting of a homogeneous necrotic area. In this manner, as a result of coagulation necrosis, the central portion of the tubercle is transformed into a broken-down mass, containing, in addition to the disintegrated cells, living and destroyed bacilli. Outside of the caseous center there are present epithelioid cells with an occasional giant-cell undergoing beginning degeneration, and at the periphery epithelioid and lymphoid cells representing the newer evolution as a result of cellular proliferation. In giant-cells the degenerative change also takes place in the center of the cell, particularly when the nuclei are disposed circularly at the periphery. Stengel and others have called attention to the fact that when the nuclei occur chiefly at one pole of an elongated giant-cell the coagulation necrosis usually takes place at the opposite pole. It has been previously stated that the tubercle bacilli, when found in giant-cells, occur at the center in case of peripheral nuclear distribution and at the pole opposite to the gathering of nuclei. It would thus seem to be a reasonable conclusion that the regional degenerative change in giant-cells corresponds closely to that portion of the cell in which the bacilli are grouped.

As the degenerative processes further advance the entire tubercle undergoes coagulation necrosis and the process of caseation becomes complete. Leukocytes are usually attracted in considerable numbers to the areas of degeneration, where they suffer the same fate as the fixed cells. The exudative processes and the resulting caseation are not confined to the tissue within the tubercle. This phase of the subject will be considered more fully in connection with diffuse tuberculous infiltration and the secondary inflammatory lesions. Of all the tissues involved in the structure of tubercle, the fibrous reticulum is the most resistant to degeneration. Connective-tissue proliferation may remain active in the periphery of the tubercle, and eventually produce a surrounding fibrous barrier delimiting the tuberculous process and entirely encapsulating the tubercle itself.

It will be seen, however, that the reactive connective-tissue hyper-

plasia is not always sufficient to effect a complete encapsulation, opportunity being afforded in many instances through the lymph-channels, and as a result of wandering phagocytes, for the deposit of bacilli in fresh tissue areas. Occasionally it does happen that the proliferation of connective tissue is sufficient to wall off entirely the tuberculous area and to produce decided contraction change. The fibrosis eventually may involve the central portion of the tubercle as well as the surrounding parts. As a result of such reorganization small foci of infection may be converted into dense cicatricial tissue comparatively devoid of blood-vessels, and producing an eventual healing of the involved area. These constructive efforts on the part of the tissues constitute the only means of securing a permanent arrest of the disease, if not obliteration of the tuberculous lesion. It is generally thought that even the formation of tubercle is a natural conservative process, although for the time being admittedly destructive in nature. To the extent that the bacilli are inclosed or imprisoned effectually within an encircling defensive wall the process of tubercle formation with associated sclerotic change may assuredly be regarded as an effort on the part of the organism toward self-protection. Although this mechanism of defense is often somewhat imperfect, it is true that the channels of escape for the bacillus are susceptible of complete occlusion by active cellular proliferation with dense connective-tissue encapsulation. This reactive protective effort of the invaded tissues is usually accepted as representing an inherent defensive action on the part of the animal organism. Theobald Smith, however, believes that there is a reciprocal protective action between the bacilli and the normal tissues, and ascribes the process of tubercle formation, with resulting connective-tissue proliferation, to an effort on the part of the parasite to obtain an abode where it may sojourn unmolested for indefinite periods.

While the bacillus undoubtedly affords the stimulus for the cellular proliferation, it would appear that the connective-tissue formation constitutes rather a mechanism of *defense* of the *tissues* against the invading parasite. It is apparent that the measure of the practical efficiency of the connective-tissue hyperplasia depends upon the rate of its formation. *In the evolution of tubercle there are present two well-defined opposing forces, the eventual supremacy of one denoting tissue repair and recovery, the other, progressive degeneration and bacillary distribution to surrounding parts.* Upon the one hand, there is a tendency for active cell-proliferation with fibrous tissue construction and encapsulation; upon the other, advancing caseation and extension of the infection to new areas beyond the limits of peripheral connective tissue. The situation resolves itself, therefore, into a race between the effort of construction and the tendency to destruction, the final issue being decided according to the relative rapidity of the contending processes. The same inclination to degeneration and to connective-tissue hyperplasia is observed in surrounding areas and even in diffuse tuberculous infiltration, large masses of involved tissue exhibiting varying degrees of necrotic and proliferative change.

An extension of the process from the initial tubercle takes place as a result of the penetration of the connective-tissue wall by the bacilli and the peripheral formation of miliary tubercles. In the same manner, from these secondary tubercles, new centers of growth are again formed. Not infrequently nodules are produced consisting of many miliary

tubercles which, as caseation advances in the center, become fused into large masses of broken-down tuberculous material, commonly called conglomerate tubercles, although by some the term "submiliary" is employed. To such masses, which sometimes attain the size of a hen's egg, the appellation "crude tubercle" was applied by Laënnec. The same processes of degeneration and repair which take place in a single elementary tubercle also obtain in all the constituent tubercles comprising the entire mass. Caseation and softening with resulting excavation may develop as a result of the coalescence of the individual tubercles, or a firm network of fibrous tissue hyperplasia may supervene in others. The destructive tendency toward cavity formation not only involves structures of tuberculous formation, but often invades pneumonic areas resulting from secondary inflammatory changes. Factors of great importance in such cases are, first, the nature of the exudative process, which, though purulent, is not necessarily due to mixed infection, and, second, the invasion of these pneumonic areas with tubercle bacilli. Even in tubercle formation, without other associated inflammatory lesions, there is usually an abundant exudation which may consist either of polynuclear leukocytes or of serum. The exudation sometimes is fibrinous and may invade the caseous tissue or cover the surface of miliary tubercles. The exudate, of whatever character, though external to the tubercle itself, may be distributed extensively in the surrounding tissue, and considerably augment the size of nodules or conglomerate tubercles. Discrete tuberculous nodules are often absent altogether, and in their place there may exist a diffuse tuberculous infiltration containing numerous giant and epithelioid cells, with varying degrees of caseation and fibrosis. In addition to the necrotic and sclerotic changes possible of development in individual tubercles or in a conglomerate mass, the process of calcification occasionally ensues. This takes place, however, only after the formation of considerable connective-tissue proliferation. The bacilli are much more frequent in the broken-down débris of these diffuse processes after softening has become advanced than in the strictly caseous material. The content of the softened tuberculous mass is a thick, creamy, yellowish material, somewhat resembling pus, though differing from it histologically. There are present much granular débris, broken-down cells, and fat-drops.

In tuberculosis of the lungs, on account of the opening of tuberculous cavities into bronchi, the conditions are favorable for the entrance of numerous pyogenic bacteria. In pulmonary tissues the characteristic tubercle formation previously described is limited somewhat by the loose anatomic structure of the parts. The tissue is not sufficient in extent nor of such character as to permit the fullest elaboration of tubercle formation, although extensive hyperplasia occurs in surrounding areas. Exceptional opportunities are afforded, however, for dissemination of the tuberculous infection by the physiologic motion of the parts, the penetration of bronchi, and the luxuriant network of lymphatic channels and blood-vessels. While the movements of ordinary respiration must be regarded to some extent as inimical to rapid tissue repair, the deep inspiratory efforts attending violent attacks of coughing are assuredly instrumental in further distribution of the bacilli throughout the respiratory tract.

A most important feature of tuberculous infection of the pulmonary tissues is the frequent extensive development of secondary inflammatory

lesions. The most perfect example of typical tubercle formation in the lungs is found in miliary tuberculosis, although even in such cases exudation is not entirely absent. The tubercles are found in the walls of the alveoli, of the bronchi, and of the blood-vessels. Areas of tuberculous bronchopneumonia with extensive retroactive inflammatory change are sometimes accompanied by miliary tubercles. These inflammatory lesions, dependent largely upon exudative processes, may partake of the nature of catarrhal or fibrinous pneumonia, and in exceptional instances give rise to marked proliferation of connective tissue, inducing pronounced contraction change. The areas of pneumonic involvement may vary greatly in size, sometimes the process being confined to tiny areas, in other instances being distributed throughout a single lobe or an entire lung. Extensive areas may be affected simultaneously, or adjacent foci may subsequently become confluent. Caseation may supervene precisely as described in connection with the elementary tubercle. The degenerative change may involve wide areas of pulmonary tissue or appear in the form of discrete foci of necrosis. The inflammatory process sometimes involves the wall of the bronchi as well as pulmonary tissue. Caseation, either with or without the formation of genuine tubercle, may develop within the wall, resulting in its eventual penetration and communication with pulmonary cavities. The process of excavation may be astonishingly rapid in areas of pneumonic consolidation, the destruction of tissue sometimes extending into and through the walls of several bronchi. The rapidity of the softening, with added increase in the size of the pulmonary excavation, is dependent largely upon the character of the tissue comprising its encircling wall. If the wall of the cavity consists of an area of tuberculous pneumonia, further excavation is much more likely than if the adjacent tissue consists of elementary tubercle formation or chronic tuberculous infiltration, in which event the conditions are much more favorable for limiting cavity formation. Thus the remarkable diversity in the rapidity and extent of cavity formation is explained almost entirely by the character of the contiguous tissue. It is not to be understood that pulmonary excavation must necessarily be accompanied by rapid softening, copious expectoration, increase of bacilli in the sputum, temperature elevation, or general decline, although such clinical manifestations are common. Neither is it always true that cavity formation is associated with further dissemination of tubercle bacilli.

The development of pulmonary hemorrhage is not always occasioned by a destructive tuberculous change involving the wall of the blood-vessels, although some are probably attributable to its caseation and rupture. In the event of cavity formation with removal of the support of the arterial wall, aneurysmal dilatation not infrequently results. Rupture subsequently takes place by reason of purely mechanical causes, without definite tubercle deposit in the wall of the artery. The small hemorrhages so frequently observed in all stages of tuberculosis, sometimes even in advance of physical signs, would seem somewhat difficult of explanation, because in areas of tuberculous deposit with or without caseation and excavation the small blood-vessels are obliterated. It is known, however, that the surrounding blood-vessels which make up the collateral circulation are engorged to a considerable extent, and at times of temporary excitement or strain are incapable of withstanding the intra-arterial pressure.

CHAPTER XV

GROSS APPEARANCES

THE macroscopic appearance of tuberculous pulmonary lesions varies remarkably according to the course, duration, type, and complications of the disease. While degenerative change may be said to constitute the chief pathologic characteristic of pulmonary consumption, there are present in many cases features of essential importance aside from recognized areas of necrosis. These consist of miliary tubercles and of differing degrees and extent of pneumonic consolidation, catarrhal inflammation, caseation, cavity formation, calcification, fibrosis, compensatory emphysema, atelectasis, both from compression and from local occlusion of bronchioles, pleural inflammation with tubercle deposit, thickening, adhesions, perforation, and resulting pneumothorax. In addition to these conditions of pathologic interest incident to the invasion of the bacillus, there is exhibited a wide divergence in different cases in the amount of connective-tissue proliferation. This may be comparatively slight or absent altogether, particularly in cases of the acute *pneumonic* type—the so-called tuberculous pneumonia. Upon the other hand, the connective-tissue hyperplasia is well marked in the more chronic cases of caseofibroid pulmonary tuberculosis, and not infrequently becomes a conspicuous anatomic feature, as in fibroid phthisis. In the same manner other pathologic conditions are subject to considerable variation in differing groups. The degenerative change may be rapid and extensive, with speedy formation of cavities, or slow and unaccompanied by recognized destruction of tissue, the process of repair being continually maintained in minute centers of infection. Generally speaking, the caseous degeneration is more marked in acute cases, in which it sometimes appears as an early pathologic manifestation. The necrotic changes leading to cavity formation, though present both in acute and in chronic cases, are not *always* exhibited in acute pneumonic phthisis on account of its *very rapid development* and brief duration. In this disease the early consolidation overshadows all other conditions and often imparts but the clinical aspect of either an ordinary catarrhal or fibrinous pneumonia, the victims sometimes succumbing before the development of extensive cavity formation. In miliary tuberculosis the degenerative process is present in disseminated tubercles, which are changed from almost invisible, gray, translucent specks into opaque, yellowish spots. In such cases gross areas of softening and excavation are seldom observed, on account of the rapid progress of the disease to a fatal termination. It is true that, exclusive of genuine miliary tuberculosis, fresh miliary tubercles may be present in association with large areas of pneumonic consolidation or with masses of caseous degeneration, but in such instances the tubercle does not form the essential or characterizing pathologic condition. Though tubercles are often found along the edges of consolidated, cheesy, or necrotic tissue, the macroscopic appearance of the involved lung, as a whole, is entirely different from that exhibited in miliary tuberculosis.

Again, pneumonic consolidation, although present in differing degrees in almost all cases of pulmonary tuberculosis, and even to some

extent in the midst of disseminated miliary tuberculosis, is not invariably a distinguishing feature. The pneumonic process may be confined to small areas in the immediate vicinity of the affected alveoli or be diffused throughout an entire lobe or lung. In acute pneumonic phthisis the exudation constitutes the predominant pathologic characteristic, whether the process appears as a distinct lobar affection or as a lobular involvement with more or less tendency toward the confluence of solidified areas. In miliary tuberculosis, however, the pneumonic condition is defined much less sharply and is usually quite subordinate to the diffusion of tubercles in the connective tissue in the vicinity of the fine arterial terminals. As a rule, the consolidation is more apparent in cases conforming to the florid type of consumption than in the more chronic varieties. In chronic fibroid phthisis the pneumonic process is subject to considerable variation in degree and distribution. The consolidation is often limited to the apex, and is sometimes present only in small areas of lobular involvement. In other cases the pneumonic process is pronounced, extensive regions becoming progressively consolidated. The formation of tubercles in the connective tissue may give rise to but slight secondary exudative change, and consequently to comparatively little inflammatory consolidation. In other instances there is an early and rapid development of caseous pneumonia, which, originating in the alveoli, is capable of considerable extension to contiguous tissues. In cases without gross pneumonic consolidation material differences exist in the intensity of the catarrhal inflammation involving the alveoli and finer bronchi in close proximity to the tubercle deposit. As previously stated, the walls of either may be the seat of tuberculous infection. Without exhibiting definite tuberculous lesions, they may be filled with an exudation arising from the inflammatory condition incident to the neighboring tuberculous focus. There may exist a disproportionate catarrhal affection either of the bronchi or of the alveoli. Essential differences in the gross pathologic appearance may arise from the nature and extent of the pleural involvement. There may be distributed upon the surface miliary tubercles, with or without local inflammatory change. A simple congestion of the surface sometimes corresponds to the area of pulmonary disease. In other cases an exudative process involves both visceral and parietal layers, which subsequently become agglutinated and enormously thickened. As further organization of the product of inflammatory action takes place, extensive contraction changes develop, involving pulmonary tissues, adjacent organs, and the chest-wall. Pleural effusion or empyema occasionally results from infection of the pleural surfaces. Pneumothorax incident to perforation of the pleura produces varying degrees of pulmonary collapse and secondary infection.

From the preceding considerations it is apparent that there is no absolute unity of the gross pathologic lesions in pulmonary tuberculosis, although the histologic identity of the primary tubercle has been long since beyond dispute. As will be seen in the accompanying illustrations (Plates 3–9), inspection of the pulmonary tissue in some cases may disclose but slight visual deviation from normal conditions, while in others the entire lung may be transformed into an unsightly mass exhibiting in places miliary tubercles, pneumonic consolidation, cheesy degeneration, calcification, softening and cavity formation, areas of atelectasis, obliteration and aneurysmal dilatation of the blood-vessels, emphysema, anthracosis,

Right lung, showing well-defined thickening of apical pleura. Areas of emphysema and bronchopneumonia. Disseminated patches of anthracosis at base. Miliary tubercles plainly recognized on section near lateral margin. Attention is called to Plate 10, representing the gross appearance of the left lung of the same individual.

PLATE 4.

Right lung from case of miliary tuberculosis. Note extensive raised areas of emphysema involving nearly all portions of the lung. Note anomaly of fissure. Note the well-defined interlobular septa. Upon section, the lung disclosed typical miliary deposit. This lung was one-third larger than the left lung from the same individual. The left lung was small, contracted, and bound down by exceedingly firm adhesions.

connective-tissue hyperplasia, and pleural thickenings. In view of the wide range of pathologic conditions, the futility of any effort toward a classic description of gross pathologic appearances, to be regarded as typical of all cases of pulmonary tuberculosis, is apparent. Present knowledge derived from increasing experience in the observation, treatment, and autopsy findings of consumption has led to a conviction of striking changes in the anatomic as well as the clinical picture. In spite of extensive destructive change representing large areas of virulent, active infection the processes of repair under proper conditions are seen to have developed to an astonishing extent. Conversely, in the midst of excessive connective-tissue proliferation, rapid changes of a tuberculous or purely inflammatory nature are found to have taken place without easily explained cause. Notwithstanding the multiplicity of these pathologic conditions and the variability of their occurrence, certain processes are sufficiently uniform to permit separate classification based upon their chronicity, gross appearances, and distribution of the lesions as follows: (1) Miliary tuberculosis; (2) acute pneumonic phthisis (lobar); (3) acute pneumonic phthisis (lobular); (4) chronic caseofibroid tuberculosis; (5) fibroid phthisis.

MILIARY TUBERCULOSIS

In miliary tuberculosis the essential feature is the presence of gray, translucent tubercles in the vicinity of the terminals of the pulmonary artery. These are often seen only with some difficulty until after they become yellow and opaque from degeneration. They sometimes increase in size, particularly as the condition becomes more chronic, but this is not very frequent. External to the periphery of the miliary nodule there develops a zone of catarrhal inflammation involving the neighboring alveoli and minute bronchi. The walls are infiltrated with an exudation of cells, become congested or swollen, and are bathed in a mucopurulent secretion which is sometimes partly hemorrhagic. In proportion to the distribution of the miliary nodules the lung becomes, as a whole, hyperemic, heavier than normal, somewhat solidified, but still containing some air. If the consolidation is extreme, the lung is sufficiently heavy to sink in water and is darkly congested. The tissue is rarely dry and friable, but is, as a rule, moist and solid on section. In chronic cases the degenerative change is pronounced and areas of yellowish, softened tissue are recognized. The nodular dissemination is often more marked at the bases than in the upper regions.

ACUTE PNEUMONIC PHTHISIS (LOBAR)

In this condition the early pathologic lesions vary but slightly, if at all, from those of ordinary croupous pneumonia. There is an early simultaneous involvement of many lobules, sometimes sufficient to include an entire lobe or the lung itself. There is noted an intense, dark-red congestion, suggestive of the pathologic appearance in ordinary croupous pneumonia. The pleura is dull, and may be covered with a thin exudate. The lung is heavy and airless. Upon section, a granular appearance may be imparted as a result of fibrinous coagulation. Discrete miliary tubercles may be scattered through the consolidated tissue, and particularly along the edges, but not infrequently these are impossi-

ble of detection. With the onset of degeneration the lung assumes a yellowish or grayish color. Softening progresses rapidly, and cavity formation results. The excavations are sometimes large, but more frequently numerous small cavities are irregularly distributed through the infected area. The softening and excavation are not due wholly to the breaking-up of the exudate, as occurs during resolution in fibrinous pneumonia, but is chiefly the result of caseation and necrosis of the pulmonary tissues. In this type of acute tuberculous pneumonia but little opportunity is afforded for the process of repair. Connective-tissue proliferation is rarely permitted to any extent on account of the acute onset and course.

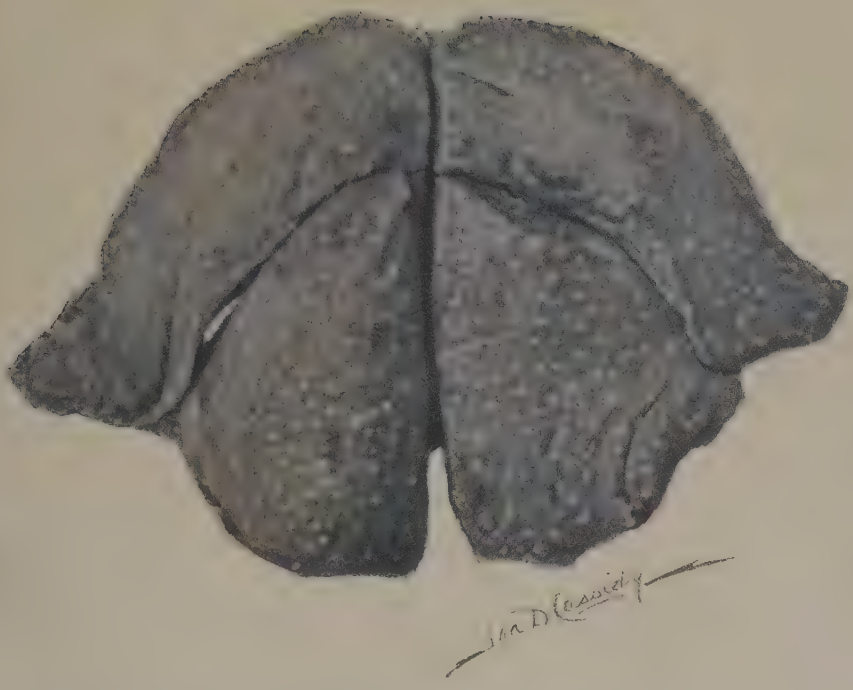
ACUTE PNEUMONIC PHTHISIS (LOBULAR)

The pathologic appearances in some respects are dissimilar from the preceding condition. The chief difference consists of the lobular distribution of the early lesions, the areas of consolidation being identical with those in catarrhal pneumonia. In some cases the consolidation starts in a small portion of lung and exhibits an apparent migratory tendency. Discrete regions of involvement not infrequently become confluent, establishing a gradual conformity to the lobar form of acute pneumonic phthisis, the exudation often containing a considerable amount of fibrin. The cells are derived from the exudative process and from the desquamation and proliferation of intra-alveolar epithelial cells. Patches of pneumonic consolidation undergoing various degrees of cheesy degeneration and softening are unevenly distributed over portions of one lung or of both, often involving the bases. Tuberculous masses vary considerably in size, and are sometimes separated from one another by intervening areas of crepitant lung tissue. The infected areas are at first grayish red, but become opaque and yellowish as degeneration advances. Miliary tubercles may or may not be present, as in the lobar type of tuberculous pneumonia. The finer bronchial tubes upon section are shown to be filled with a purulent exudate, cheesy degeneration taking place in the surrounding tissue. The areas of caseation become larger, more moist, and softer, until irregular excavations make their appearance.

CHRONIC CASEOFIBROID PHTHISIS

In this form of tuberculosis there may be exhibited in various degrees all the gross pathologic lesions described in connection with other varieties of pulmonary consumption. There are found miliary tubercles consisting of a number of submiliary or true elementary tubercles, larger nodules of conglomerate tubercle formation, areas of diffuse tuberculous infiltration, secondary inflammatory lesions represented by isolated or confluent patches of pneumonic consolidation, cheesy degeneration of the tuberculous tissue, marked exudative processes, necrotic changes leading to cavity formation, and, finally, a more or less extensive proliferation of fibrous tissue in the infected areas. Before discussing these respective anatomic lesions seriatim, it is well to call attention to the following facts: (1) On account of the insidious and localized development large areas of consolidation are rarely present in early stages, the process being usually limited to a small patch of tuberculous

PLATE 5.



Miliary tuberculosis of lung from infant six months old. Specimen hardened in formalin. Note tubercles studding the pleura—their irregular size and distribution.

PLATE 6.

Section of lung hardened in formalin, showing distribution of miliary tubercles. Note calcareous deposits.

PLATE 7.

Section of lung hardened in formalin, showing patches of pneumonic caseation at lower region, with cavity formation in the upper portion. Note blood-vessels traversing the upper cavity.

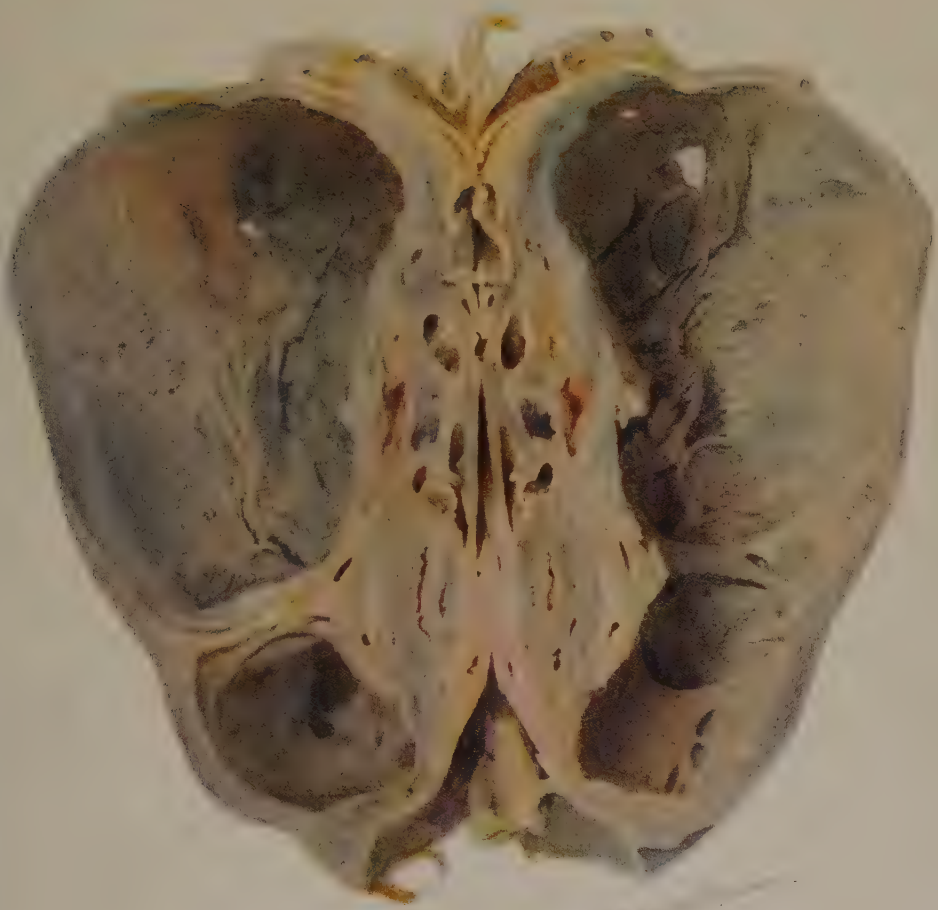
infiltration in the apical region. (2) Typical tuberculous nodules often undergo characteristic degenerative and reparative changes, and are found in connection with small localized areas of pneumonic infiltration proceeding from centers of tuberculous infection. (3) The process of degeneration is seldom rapid, though often progressive in character, excavation taking place, as a rule, comparatively slowly. (4) Owing to the chronicity of the course, opportunity is afforded to a greater or less extent for connective-tissue hyperplasia, the constructive and destructive processes being maintained jointly for somewhat prolonged periods. In chronic caseofibroid phthisis there may be present small tuberculous nodules composed of a number of elementary tubercles involving the peri-alveolar and peribronchial tissues, and extending into the alveoli themselves. The finer bronchioles and surrounding tissues are invaded also by an exudative process. The terminal bronchioles are occluded as a result of the secondary inflammatory lesion, which subsequently undergoes degeneration jointly with the tubercle itself. On account of the extension of the infection to contiguous structures through the medium of the lymphatics and by the discharge of tuberculous material into adjacent bronchi, the area of disease tends to increase progressively in size. As a result of the degenerative process the consolidated tissue presents an opaque, homogeneous, yellow appearance, in which the tubercle formation is not, as a rule, perfectly distinct. Tubercles are often recognized, however, along the edges of the tuberculous masses before the degenerative change has become complete. The surrounding involved area is usually congested and at least partially consolidated. Upon cross-section the lung may present here and there a similar appearance to that described in connection with the more acute forms of pulmonary tuberculosis, particularly if the process at such points has been at all active. The bronchi may be completely occluded by cheesy or purulent tuberculous material. The lumen is not always plugged entirely with cheesy exudate, and a small orifice can sometimes be detected in the center of a tuberculous nodule undergoing caseous degeneration. If the bronchial tube is cut longitudinally, it may be found filled with broken-down tuberculous detritus. These masses of diseased tissue undergoing cheesy degeneration correspond to the so-called crude tubercle of Laënnec, and may attain a diameter of one to two inches. The secondary inflammatory processes in the neighborhood of tuberculous foci are sufficient in some cases to produce extensive confluent areas of consolidation, as in the more acute forms of pulmonary involvement. The infiltrative process may present the appearance of red hepatization in portions of the lung, while in other places the evidence of degenerative change is very apparent. Areas of pneumonic consolidation not undergoing degeneration sometimes exhibit a granular or gelatinous aspect.

Another form of pneumonic consolidation results from hemorrhage occurring in the course of chronic pulmonary tuberculosis. The blood is frequently inspired into the finer bronchi and alveoli, and not only diminishes to a considerable extent the respiratory capacity, but also favors the development and growth of secondary pathogenic microorganisms. A diffuse non-tuberculous bronchopneumonia (septic) often ensues, and occasionally gangrene.

Pulmonary excavation constitutes a characteristic lesion of pulmonary tuberculosis, and exhibits marked differences in size, rapidity of development, and in the nature of the tissues constituting the encir-

cling wall. As previously explained, the degenerative process leading to cavity formation may take place in the pulmonary tissues and finally extend to the wall of a bronchus, which subsequently ulcerates and permits the evacuation of the liquefied contents. At other times the excavation originates with the dilatation of a bronchial tube the walls of which yield to the nutritive and necrotic changes accompanying stagnating secretions. Other elements in the formation of the bronchiectatic condition are intrabronchial pressure due to very violent paroxysmal attacks of coughing, and in some instances to traction exerted upon the external wall as a result of surrounding fibroid change. The dilatation is also facilitated in many cases by necrotic changes in the surrounding pulmonary tissue. As dilatation advances ulceration of the wall takes place, accompanied by extension of the necrosis into the contiguous pulmonary tissue, and further excavation ensues. The initial tuberculous process sometimes invades the wall of the bronchus, producing perforation and extension to surrounding tissues. Pulmonary cavities frequently become the seat of secondary infection, which further facilitate the process of destruction. Increase of size occurs as the result of a progressively extending degeneration and necrosis in the vicinity of a single cavity, or by the fusion of several smaller excavations. A series of cavities sometimes connect with one another in this manner. In almost all instances the cavity opens into a bronchus, affording opportunity for the evacuation of the contents, which consist of offensive purulent secretion with degenerated cells, elastic fibers, detritus, tubercle bacilli, and pathogenic microörganisms. A considerable difference is noted in the character of the walls. When the degenerative process is rapid, as in acute pneumonic phthisis, the wall consists of an irregular mass of yellowish-gray caseous tissue. Sometimes the degree of excavation is indeed remarkable, even an entire lung being broken down into an enormous cavity, as illustrated in plate 8. Perforation of pleura, producing an open or valvular pneumothorax, not infrequently results from the existence of cavities beneath the visceral layer.

In the more chronic forms of pulmonary tuberculosis the walls of most cavities are somewhat defined by fibrous tissue proliferation. In place of an encircling area of tuberculous pneumonia undergoing degeneration, as in the acute forms of phthisis, there may be miliary tubercle formation, associated with considerable fibrous tissue hyperplasia. Pus is produced from the granulation tissue constituting the inner surface. This surrounding fibrous tissue is usually more or less vascular or hemorrhagic, and is frequently spoken of as the "pyogenic membrane." The walls may be smooth or rough, and irregular from protruding remnants of pulmonary tissue or traversed by blood-vessels with or without aneurysmal dilatation. As previously shown, these vessels are sometimes obliterated following occlusion of the lumen with thrombi. They often pass directly through portions of the cavity, and present varying degrees of saccular dilatation incident to the absence of external support. The cavities may exist in any portion of the lung, although found more frequently at the apex. The increase of size is slow in proportion to the amount of surrounding connective-tissue hyperplasia. When the walls consist of dense cicatricial tissue, the further progress of the excavation is almost entirely checked. If the cavities are small and the surrounding fibrosis extensive, there is not only an encapsulation of the diseased area, but often a resulting obliteration of the cavity itself. I



Section of lung hardened in formalin, showing the two halves open. Enormous cavity formation. Note connection between the upper and lower cavities. Note the smooth inner surface of cavity, with almost entire absence of trabeculæ or vessels. Areas of caseous pneumonia in the lower portion of the lung.

have noted many times, after the lapse of several years, a complete disappearance of the physical signs of pulmonary cavities the existence of which had been previously established. In a few cases the skiagraph has served to demonstrate the apparent obliteration of pulmonary cavities in individuals exhibiting undoubted evidence of excavation upon previous *x*-ray examination. Tubercle bacilli have been identified in the walls of pulmonary cavities which are undergoing rapid cheesy degeneration and necrosis. They are, as a rule, less virulent in old cheesy foci, and may be absent or at least infrequent in cavities whose walls consist of contracting cicatricial tissue.

The data secured from clinical observation lead to the conclusion that cavities are exceedingly likely to develop in the upper portion of the lung from the clavicle to the third rib, and in the back in the interscapular space.

CHRONIC FIBROID PHTHISIS

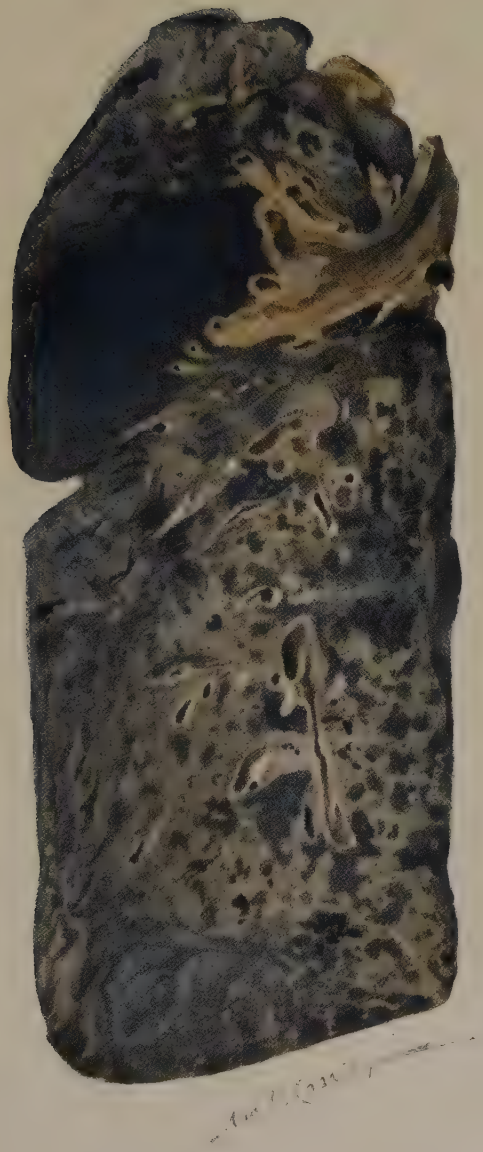
While in caseofibroid phthisis the process of repair is exhibited to a varying degree, in the condition known as fibroid phthisis the connective-tissue proliferation is particularly excessive. In early cases of chronic pulmonary tuberculosis the small tuberculous areas are surrounded by connective tissue. This fibrous hyperplasia is present to some extent in the peripheral portion of each elementary tubercle, and also constitutes an encircling wall involving the entire tuberculous mass. The diseased tissue may thus become circumscribed entirely by the protective barrier, dense puckering of cicatricial tissue resulting from advancing fibrosis and contraction. In other cases calcareous metamorphosis of the cheesy material takes place within the encapsulated area. Pulmonary concretions are formed in this way, and are sometimes expectorated in the act of coughing. It occasionally happens in cases of incomplete calcareous change that the capsule is perforated even after many years of apparent arrest of the tuberculous process, thus permitting fresh areas of infection. In fibroid phthisis the connective-tissue proliferation extends from minute foci of infection which are sufficiently confluent to form masses of conglomerate tubercles, and are not associated with diffuse infiltrative change or pneumonic consolidation. Bands of connective tissue proceed from the great vessels and bronchi into the pulmonary structures, which eventually become interwoven by a dense fibrous organization. The tissues thus permeated by fibrous hyperplasia become the seat of excessive contraction change, the sclerotic condition often invading all portions of the lung. It is not infrequent that extensive areas of connective-tissue proliferation are present in certain portions of a diseased lung, while a more recent active tuberculous infection is progressing in other parts. Although in many cases of fibroid phthisis isolated areas of tubercle deposit alone are encapsulated and interspersed by the connective-tissue hyperplasia, the reparative process sometimes becomes so overdeveloped as to produce extensive pleuritic adhesions and contractions, diminishing materially the respiratory capacity. Pleuritic adhesions are, of course, frequent in practically all varieties of pulmonary tuberculosis, and result from the presence of a fibrinous inflammatory exudate upon the surface. The pleura may be thickened enormously, with miliary tubercles sometimes found upon the surface. The pleural cavity may become the seat of a suppurative process from the entrance of tubercle

bacilli and the microörganisms of mixed infection which proceed from contiguous areas of disease. In case of perforation of the pleura with entrance of air to the pleural cavity the resulting pulmonary collapse is complete or partial, according to the presence or absence of firm pleuritic adhesions.

SITE OF PRIMARY INVOLVEMENT

The initial point of election in pulmonary tuberculosis has been the subject of considerable clinical and pathologic study in recent years. It was formerly believed that the infection orginated at the very apex of the lung, and proceeded downward as a result of the inhalation of the tuberculous material to other portions of the respiratory tract. Special opportunities for the spread of the infection were believed to be afforded by the conveyance of the bacilli to previously uninfected areas through the inspiratory efforts incident to coughing. Localized catarrhal conditions of the finer bronchi were thought to be followed by tuberculous ulceration and by the penetration of bacilli into the peribronchial tissues. The predilection of the tubercle bacillus for the apical region, while universally recognized, was definitely attributed to such general causes as a weakened resistance of the tissues at this location, stagnation of the circulation, diminished respiratory excursion, retention of bronchial secretions, and the effects of prolonged maintenance of stooping postures incident to certain vocations. For a long time the opinion was entertained that the infection was more likely to involve the left apex than the right, on account of a difference in the angles of the primary bronchi with the trachea. Apical involvement, however, was not frequent in children in whom other portions of the lungs were often primarily affected. The initial tuberculous process in cattle was found at the tip of the caudal lobe. It has not been made clear that the circulation at the apex is materially enfeebled, and it is difficult to reconcile the theory of a localized region of lessened resistance with the clinical fact that tuberculous infection of the apex is frequently susceptible to complete arrest. Osler reports, out of 427 cases, the right apex was found involved in 172, the left in 130, and both in 11. Out of 2070 cases of my own whose records have been preserved, the clinical evidence pointed to priority of infection at the right apex in 978 cases, and at the left in 783. At the time of first examination lesions were recognized in both apices in 1096 cases, the tuberculous process being about equally advanced upon the two sides in 117. Aufrecht's theory, which has been substantiated by the experiments of Calmette, Guerin, and others, was to the effect that the bacilli gained entrance to the great veins and obtained a lodging-place in the terminals of the pulmonary arteries at the apex. This effectually disposes of the common error that the site of the initial lesion is indicative of the point of entrance of the bacillus into the body. It may be assumed that tubercle bacilli are inhaled to an equal degree into all portions of the respiratory tract. Upon the theory, therefore, of inhalation tuberculosis, no reasonable or satisfying explanation has been advanced relative to the frequency of apical involvement resulting from certain predisposing mechanical conditions at this point. Upon the basis, however, of localized infection through the blood-vessels, the constancy of apical infection is possible of explanation through the influence of the lymph-streams.

PLATE 9.



Section of lung hardened in formalin, showing extensive areas of anthracosis. Note not only the involvement at root, but also the disseminated areas at the base. Note fibrous puckering at apex.

Cobb has called attention to the *vis à fronte*, or suction pull, which countercurrent arises from the great veins and lymphatic vessels in the angles of the neck, producing an area of lymphatic stasis in the apices of the lung. It is known that the primary lesion of tuberculosis is not at the extreme apex, but at a point somewhat below, varying, according to the reports of several investigators, from one-half an inch to one and one-half inches below the summit of the lung, and usually somewhat nearer to the posterior surface. Fowler believes that the location of the initial lesion is also nearer the external border. The primary focus is reported by him to correspond to a point a little below the middle portion of the clavicle, and to extend along the anterior border of the upper lobe. Several authors corroborate this initial area of infection by the detection of early physical signs at the middle of the clavicle, or just below it, and sometimes in the supraspinous fossa. Another point of early infection, as indicated by Fowler, is found below the outer third of the clavicle, with downward extension along the outer portion of the upper lobe. Involvement of the lower lobe is described as taking place slightly below its apex in the posterior portion, on a line with the fifth dorsal spine. Some observers have gone so far as to state that the apex of the lower lobe is affected in the great majority of cases in which the physical signs of tuberculosis were recognized at the apex of the upper. They assert that the tuberculous process does not involve the opposite upper lobe until the apex of the lower lobe of the lung first diseased has become the seat of tuberculous lesions. While infection readily extends upon the right side from the upper to the middle lobes, and upon the left from the upper to the lower, it is questionable if, as claimed, the process has invariably invaded the upper portion of the lower lobe before the disease is recognized in the other apex. From a purely clinical standpoint, it may be asserted that the physical signs are sometimes recognized posteriorly before the anterior apex is involved. The initial physical evidences are observed very much more frequently above the clavicle than below. They may be detected extending downward from the clavicle along the anterior and internal border of the lung, in the absence of physical signs in the middle or outer portion. The outer portion of the upper lobe below the clavicle is rarely found to be the seat of tuberculous invasion without the existence of physical signs along the internal or anterior border. The upper portion of the lower lobe is often invaded simultaneously with the recognition of the disease in the apex of the upper lobe. In numerous instances I have been able to detect incipient lesions at this point without physical signs at the very apex, either front or back. Upon the other hand, it has not been my experience clinically that the upper portion of the lower lobe is invariably affected before the tuberculous process extends to the opposite side.

PART II

SYMPTOMATOLOGY AND COURSE, VARIETIES AND TERMINATION

SECTION I

SYMPTOMATOLOGY

INTRODUCTION

A STRIKING characteristic of the general manifestations of pulmonary tuberculosis is the lack of uniformity of clinical features. Physicians who are at all familiar with the symptomatology of consumption will unite in denying the existence of a sole conventional type of the disease. In no other department of medicine is the observer privileged to witness a wider diversity of clinical phenomena, or required to exercise greater powers of discrimination and judgment in estimating the import attached to various symptoms. There are few features truly typifying the disease which may not occur in other pulmonary affections. No single symptom is invariably exhibited, and each case must be adjudged strictly in accordance with its own intrinsic merits. Certain subjective symptoms may definitely characterize some cases of consumption and yet be entirely absent in others. A few manifestations may be possessed of great clinical import or of comparatively slight significance, according to the widely differing associated conditions. Furthermore, the same rational signs displayed by a single individual at *different* times during the course of an active tuberculous infection may constitute clinical data of *varying* degrees of importance. The *early* manifestations of pulmonary tuberculosis, although often vague and ill defined, are of great essential interest. In no way is the diverse symptomatology more definitely illustrated than in the manner of onset of the disease in different individuals. It is possible, within somewhat flexible limits, to designate certain so-called types of onset to which most cases of tuberculosis may be said to conform.

CHAPTER XVI

METHOD OF ONSET

THE manner of invasion may be regarded as *acute* or *non-acute*. The *acute onset* of tuberculosis may occur in the form of—(1) Acute pneumonic phthisis; (2) acute bronchopneumonic phthisis; (3) acute miliary tuberculosis of the pneumonic type; (4) initial pulmonary

hemorrhage; (5) acute pleurisy; (6) acute septic manifestations; (7) acute bronchitis; (8) la grippe or influenza.

Acute Pneumonic Phthisis.—The early manifestations of acute pneumonic phthisis are essentially the symptoms of ordinary croupous pneumonia. Following an initial rigor, there takes place an abrupt rise of temperature, which remains elevated without pronounced remissions during the first few days. There is often pain of a stabbing nature in the side, due to coincident pleural involvement. The face is flushed, eyes bright, and expression anxious. The cough is frequent, dry, distressing, and restrained, the expectoration being scanty and tenacious. The sputum is occasionally streaked or flecked with blood, but is sometimes distinctly hemorrhagic in character. The pulse is accelerated, and the respiration rate markedly increased. Headache and other constitutional disturbances are present. Digestive disorders are frequent, the stomach usually being non-receptive to other than liquid food, and the bowels constipated. The urine is scanty, of high specific gravity, and containing often a trace of albumin. The physical signs are characteristic of croupous pneumonia. In short, there is nothing in the early clinical picture to direct the attention of the medical attendant to the possibility of a tuberculous invasion. No suspicion is entertained as to the true character of the disease until the predicted resolution fails to take place in the neighborhood of the tenth day. Even at this time the condition is often regarded as simple pneumonia with delayed resolution, and not until several days later is there a beginning realization on the part of the physician concerning the unfortunate possibility of acute tuberculous involvement. Tubercle bacilli, even if looked for, are rarely found during the first few weeks. Following the initial symptoms there is noted, as a rule, an irregularity of the temperature, with morning remissions and evening exacerbations. The temperature is sometimes higher in the morning than in the afternoon, representing the so-called inverse type of fever. There is a tendency toward sweating, the surface of the body often being drenched with perspiration after an abrupt decline of the fever. The loss of flesh and strength is rapid and relentless. The expectoration gradually becomes more profuse and assumes a purulent character. Areas of softening are detected in the midst of the consolidated lung, and cavity formation speedily supervenes. At this time, if not before, bacilli and elastic fibers are recognized in the sputum. The condition may become progressively worse and the patient die within a few weeks, or the severe symptoms may abate to some extent and the case resolve itself apparently into ordinary chronic phthisis. Cases of acute pneumonic tuberculosis, as well as those of acute bronchopneumonic phthisis, are frequently designated as "phthisis florida" or "galloping consumption." Technically, it would seem better to confine these appellations to cases of acute ulcerative phthisis of *non*-pneumonic onset.

Acute Bronchopneumonic Phthisis.—This method of initial tuberculous invasion may occur among adults or children. In adults particularly the symptoms are those of an ordinary bronchopneumonia developing either in the midst of apparent health or following physical debilitation from various causes. The onset is usually somewhat less acute than in the pneumonic form described above, the rise of temperature being not so sudden or extreme. There may be premonitory chill, with pain in the side, but these symptoms are often absent.

There are early cough and expectoration, with moderate constitutional disturbance. Dyspnea, headache, acceleration of pulse, and general prostration in the initial stages are rarely as pronounced as in the preceding form. The patient is compelled to go to bed, however, in a few days, if not at once. Examination of the chest discloses areas of defective resonance, with characteristic changes in the pitch, quality, intensity, and rhythm of the respiratory sounds. These scattered patches of consolidation may be separated by normal lung tissue, and recognition of the physical condition may thus be rendered exceedingly obscure. The signs are usually bilateral, although occasionally confined to one side. Numerous bubbling râles are recognized throughout the affected regions, and the condition is regarded merely as one of simple bronchopneumonia. The *persistence* of the subjective symptoms and physical signs finally suggests the possibility of tuberculosis, the confirmation of which is secured through detection of bacilli in the expectoration. It is not unusual for the patient to lapse into a state resembling that of typhoid fever, with delirium, intense headache, dry tongue, and eventually complete coma. A rapid extension of the tuberculous process takes place, the areas of consolidation merging into one another until the larger portion of one or both lungs may exhibit massive tuberculous lesions. Death may take place in from three to six weeks, or, as in acute pneumonic phthisis, there may result such a stay of acute manifestations as to justify a clinical assignment of the case to the class of chronic tuberculosis. It should be borne in mind that death occurring from acute bronchopneumonia incident to hemorrhage among phthisical patients is the result of a non-tuberculous, septic, or aspiration pneumonia, to which detailed attention will be given subsequently.

Tuberculous bronchopneumonia in children is often more acute than in adults. It is most frequent as a complication or sequel of measles and whooping-cough. It may occur not only during the height of the original disease, but as well in the midst of convalescence. The patient may succumb in a very few days, apparently from ordinary bronchopneumonia. The children, however, sometimes improve after one or two weeks of acute illness, and enter upon a period of more gradual decline, with progressive loss of flesh and strength.

Acute Miliary Tuberculosis of the Pneumonic Type.—This, like the preceding, may develop in adults or children. The condition is in reality a general systemic involvement, with predominating symptoms in the lungs. In children the mournful affection may follow measles or whooping-cough, with symptoms not very dissimilar from those of acute bronchopneumonic tuberculosis. If the child survives very many days, which is seldom the case, meningeal symptoms are almost sure to supervene. In adults the condition may develop in those who already exhibit manifest evidences of tubercle deposit, and in many instances among individuals who unconsciously harbor latent foci of infection. The cough is variable, and the expectoration, if any, is very scanty. The striking symptomatic features are the dyspnea and cyanosis, both of which are quite disproportionate to the physical signs, which are those of a diffused bronchiolitis. Numerous very fine moist râles are heard throughout both sides of the chest. These may be unrecognized upon easy breathing, but clearly appreciated following a cough. Frequently there are no other auscultatory signs, and upon percussion no evidences of consolidation. There is marked loss of

flesh and strength, which is attended by increasing dyspnea and cyanosis, with or without especial elevation of temperature. The pulse almost invariably is rapid and of poor quality. In some cases the spleen is found to be enlarged. The duration is usually short, meningeal tuberculosis often developing in case the disease is at all prolonged. Acute general miliary tuberculosis will be considered in a separate section.

Initial Pulmonary Hemorrhage.—In a surprisingly large number of cases hemorrhage is the first symptom distinctly referable to the onset of pulmonary tuberculosis. It may occur in the midst of apparent health, the patient being well nourished, without cough, expectoration, or fever, and entertaining not the least notion of approaching danger. In many of these cases thorough examination of the chest fails to disclose the slightest pulmonary lesion, although in others physical evidence of incipient infection may be recognized. The initial hemorrhage without regard to the physical signs may be small, moderate, or copious. The expectoration of blood-stained mucus, which is produced by a congestion of the bronchial mucosa, has but slight significance in this connection.

Formerly it was believed that early hemorrhages were not so much the *result* as the *cause* of tuberculosis, but this theory is now known to be utterly untenable. Tubercle bacilli have been found in the fresh blood of the initial hemorrhages. It has been taught that hemorrhages of any considerable size can result only from the rupture of an artery traversing a pulmonary cavity, the wall of the blood-vessel being without its normal connective-tissue support and finally yielding to intra-arterial pressure. If this were the only cause of moderate or large-sized hemorrhages, it would be hard to explain their very frequent occurrence among patients exhibiting no symptoms or physical signs of tuberculous infection. It seems reasonable to assume that many of the early hemorrhages are produced by a beginning tubercle deposit involving the wall of the artery itself, before any considerable destructive change has taken place in the pulmonary tissue. The wall of the blood-vessel is weakened as a result of caseation, and perforation takes place before the appearance of subjective symptoms or physical signs. Another cause, though perhaps less frequent, may be assumed to be the obliteration of the terminal branches of the pulmonary artery through early tuberculous infection, increasing the intra-arterial pressure just behind the point of obstruction. Hemorrhages from these causes are likely to be comparatively small or moderate in size. I have known, however, many serious and copious hemorrhages to take place as the very first symptom of pulmonary tuberculosis.

Hemorrhages which result from genuine cavity formation and pulmonary aneurysms are especially severe and often immediately fatal, but these rarely appear as an initial symptom.

An interesting consideration relates to the *time* of the development of other manifestations following the preliminary hemorrhage. In many cases, particularly if the bleeding is severe, a persisting cough at once makes its appearance, together with varying elevations of temperature, expectoration, loss of flesh and strength, and the physical evidences of tuberculous disease. In these cases, while the hemorrhage is the immediate *precursor* of rational symptoms and physical signs, it is by no means the *cause* of the infection. In many cases the early hem-

orrhage is followed by an apparent complete recovery, several months or even years elapsing before the recurrence of pulmonary symptoms. In nearly all cases, however, the unmistakable manifestations of tuberculosis are delayed only for the time being.

In 1901, in an analysis of 900 private cases of pulmonary tuberculosis, I found that 175 patients, or about 20 per cent., gave the history of a sudden hemorrhage as the first symptom of their intrathoracic disease. Out of a recent analysis of 2070 cases of pulmonary tuberculosis 347, or about 17 per cent., were found to have had a pulmonary hemorrhage as the initial symptom of the tuberculous infection. In addition, 25 were found to present a history of hemorrhage one year before the clinical recognition of the pulmonary affection, 13 two years before, and 32 over two years.

The subject of pulmonary hemorrhage will be discussed later in more detail.

Acute Pleurisy.—It has been known for many years that a large majority of the so-called idiopathic pleurisies are tuberculous in character. While many pleurisies, either with or without effusion, end in apparent recovery, some are followed after the lapse of months or years by the development of pulmonary tuberculosis. It is not very uncommon to observe patients whose cough, expectoration, fever, and physical signs immediately follow the acute pleural invasion or so shortly thereafter as to justify their classification as cases of acute onset characterized by an initial pleurisy.

Out of 2070 recorded cases of pulmonary tuberculosis, I have found 126 presenting the history of an idiopathic pleurisy as the first symptom referable to the disease.

The presence of tubercle bacilli in the pleural effusion is a matter of comparatively little clinical moment. I have demonstrated their presence in some cases, while in others the bacilli have appeared subsequently in the sputum despite negative examinations of the exudate. Involvement of the pleura will be discussed at some length under Complications.

Acute Septic Disturbances.—A number of patients present the history of an initial chill with a sharp rise of temperature as the first manifestations of tuberculous infection. The constitutional disturbances may later become profound, even in the absence of any immediate suggestion of pulmonary disease. The chills may be of daily occurrence and of variable intensity, ranging from a succession of severe rigors to slight chilly sensations along the spine. The temperature is often subnormal in the morning, ascending rapidly in the afternoon, falling abruptly in the evening or at night, and followed by more or less perspiration. There are headache, pain in the limbs, loss of appetite with digestive disorders, rapid emaciation, and marked prostration. (See chapter devoted to Mixed Infection, p. 541.) Such cases occasionally are regarded as malarial in origin, and sometimes are thought to be of a typhoid nature. Cough, expectoration, and all other symptoms of pulmonary infection may be absent at first, but after a short time searching examination will disclose the physical signs. The spleen is usually enlarged, and a moderate leukocytosis is present. The failure of the Widal reaction and the absence of the malarial plasmodium in the blood are sufficient to call attention to the possibility of tuberculous infection even before the recognition of physical signs. I have had

occasion to observe a very considerable number of patients presenting the histories of supposed malaria or typhoid fever, for which they had been treated for weeks or months. It is of interest to note, however, that many such invalids later exhibit the clinical manifestations of a general miliary tuberculosis, the early symptoms corresponding to the so-called typhoid type, with pulmonary or meningeal symptoms subsequently developing.

The Bronchitic Onset.—With some patients the contraction of a severe cold is stated to be the first symptom of pulmonary tuberculosis. Many of these present the history of recurring bronchial attacks which gradually became more frequent and of increased severity, until the cough was persistent and other symptoms of tuberculosis were well defined. Many pulmonary invalids assert that their early symptoms were traceable directly to a single severe cold with pain in the chest, cough, and expectoration, which they since had been unable to overcome. Phthisical patients displaying a distinct bronchitic onset almost invariably exhibit a striking degree of bronchial irritation throughout the subsequent course of the disease, the cough being distressing, paroxysmal, and entirely out of proportion to the extent and activity of the tuberculous process.

La Grippe or Influenza.—For six or seven years following 1890 la grippe was a most potent factor in the causation of pulmonary tuberculosis. During these years the frequency with which patients ascribed their early symptoms of tuberculosis to an acute attack of la grippe was quite remarkable. In 1897, out of 200 cases of tuberculosis then under observation, 19 per cent. traced the origin of their trouble to an attack of influenza which was frequently of but a few days' duration. This proportion has diminished perceptibly in succeeding years.

An interesting feature of the development of consumption following la grippe has been the benign character of the original influenza infection. Another extraordinary phase of the la grippe influence is the fact that in a large number of cases there was no cough or bronchial disturbance attending the early influenza. Pulmonary tuberculosis has often developed shortly after the onset of the cerebral or tonsillar forms of la grippe, as well as following the bronchial type. This suggests the thought that the essential influence of la grippe as an etiologic factor consists of the sudden and extreme lowering of individual resistance affording opportunity for rapidly advancing tuberculous infection.

The **non-acute** onset of tuberculosis may develop as a latent unsuspected infection, as the anemic variety, and the dyspeptic type. It also may appear with laryngeal symptoms, following tuberculous cervical glands and remotely following pleurisy, pneumonia, typhoid fever, measles, or other infectious diseases.

As a Latent Unsuspected Infection.—Patients occasionally state that the first intimation of existing tuberculous involvement was the medical report when presenting themselves for life-insurance examinations, or seeking counsel on account of vague general disorder. These people often deny the existence of cough or expectoration, but sometimes admit a slight clearing of the throat, especially in the morning. Close questioning may elicit the admission of a dry, hacking cough which

has been so slight as almost to escape attention. There is, as a rule, but little loss of weight or strength. Fever has remained unsuspected, but the intelligent and frequent use of the thermometer will show in most instances either a slight afternoon elevation of temperature or at least an average for the day somewhat above normal. As time elapses these patients complain of tiring more easily than formerly. A beginning shortness of breath is noticed upon exertion, the cheek flushes, the eye becomes bright, and actual cough with expectoration calls attention to an infection hitherto latent.

The Anemic Onset.—Like the preceding, the anemic type of beginning tuberculosis is often devoid of symptoms suggestive of pulmonary disease. The onset is essentially slow and insidious. The early symptoms are of a general character, and are usually ascribed to other causes than an intrathoracic affection. The patient is noticed to be "running down," and a gradual but progressive loss of weight is apparent. Pallor is a more or less striking feature, together with shortness of breath and dizziness. At best there is a tardy and incomplete appreciation on the part of the patient, friends, and medical adviser of the gravity of the situation. This method of development is diametrically opposed to the bronchitic type of onset in that the tuberculous process in the lung is greatly disproportionate to the bronchial disturbance. Cough is a comparatively unimportant symptom, and appears as a conspicuous feature only after extensive pathologic change has taken place. Even when the disease has advanced considerably the evidence of bronchial irritation may remain quite imperceptible. Extensive destructive change in the lung usually takes place before a recognition of the real nature of the disease. Because of its insidious onset and the unconscious adaptation of the patient to the condition, much valuable time is lost before there is attained a full realization of its importance.

The Dyspeptic Type.—Patients sometimes ascribe the beginning of their disease to severe dyspeptic disorders. There are experienced loss of appetite, vomiting, anorexia, and gastralgia with acid eructations. Failure to ingest a proper amount of nourishment is attended by picturesque disturbances of a psychoneurotic nature. With insufficient food and profound depression of spirits there ensue progressive emaciation, diminished resistance, and a gradual development of tuberculous infection. Such patients are tremendously handicapped in their effort to secure subsequent arrest because of the symptoms commonly referred to the stomach, yet often of unquestionable psychoneurotic origin. In the same way preconceived notions as to inability to take certain varieties of food greatly interfere with the ultimate chances of success. This subject will be considered more fully in succeeding pages.

Laryngeal Manifestations.—In some instances the first complaint is that of slowly developing hoarseness. There may be no cough or expectoration, fever, loss of weight or strength. The hoarseness is often regarded as simply catarrhal, and attributed to an insignificant cold. After persisting for a somewhat protracted period, laryngoscopic examination discloses suggestive evidence of pulmonary infection. As a rule, the lung involvement antedates the laryngeal process, but is sometimes so slight in its extent and activity as to render difficult its early detection, the hoarseness thus developing as the first symptom of the disease. (See Tuberculosis of the Larynx.)

Following Cervical Lymphatic Tuberculosis.—While pronounced tuberculous involvement of the lymphatic glands of the neck, with or without suppuration, may persist for many years, in the absence of pulmonary infection such condition nevertheless must be regarded as a distinct menace to the individual. That pulmonary tuberculosis may develop eventually from this source, as well as from *concealed* glandular foci in other parts of the body, is too well known to warrant more than passing allusion. As a matter of clinical observation, tuberculosis of the cervical lymphatic glands not uncommonly is found to be a preliminary manifestation of pulmonary invasion. In some instances the scrofulous type of infection may strongly predominate in spite of a developing pulmonary process. In such cases the physical signs may be of trifling importance in comparison with the degree of cervical enlargement and characteristic constitutional disturbances. A pronounced lymphatic involvement may produce but a slight pulmonary invasion, but a small non-suppurative cervical gland, devoid of inflammation and freely movable under the skin, may serve as the point of departure of an extensive and active pulmonary infection. Glandular tuberculosis will be discussed quite fully under Complications.

Remotely Following Pleurisy, Pneumonia, Typhoid Fever, Measles, or other Infectious Disease.—Patients sometimes report a condition of perfect health until overcome by a severe attack of one of the acute infectious diseases. Although convalescence is sometimes slow and unsatisfactory, they apparently recover in part from the primary disease, but fail to regain to the full extent their former strength and endurance. They resume their usual occupation, but feel tired and weak, with evidently diminished powers of resistance. After varying periods the cough, expectoration, loss of weight, and other symptoms of tuberculosis make their appearance. In such cases the evidence of an increased receptivity of the soil through the influence of the infectious disease in individuals previously in good health seems too strong to admit of reasonable doubt. The effect of pregnancy will be considered later.

It should be borne in mind that in very many instances the peculiar type of onset stamps its impress upon the subsequent course of the disease, and to a marked extent influences prognosis. This will be treated more fully in connection with the Clinical Course and the Prognosis.

CHAPTER XVII

COUGH AND EXPECTORATION

COUGH

THERE is no manifestation of pulmonary tuberculosis more popularly regarded as suggestive of the disease than cough, and yet none is more subject to variations in its character and extent. There is no definite relation between this symptom and the activity of the tuberculous

process or the nature of the pathologic change. Several times I have observed individuals exhibiting pronounced physical evidences of cavity formation and with wide areas of tuberculous disease, who at *no time* presented the history of cough or expectoration. More frequently the reverse of this is observed, *i. e.*, that the cough is out of all proportion to the extent of structural change. In reality the cough is but a reflex phenomenon resulting from various degrees of irritation of the bronchial mucosa, often quite independent of the tubercle deposit. It is usually excited by the presence of secretion, the most sensitive portions of the respiratory tract being at the bifurcation of the trachea and the interarytenoid commissure. The cough, as a rule, is more pronounced upon awakening in the morning, by virtue of the fact that the secretions have been permitted to accumulate during the night, and the reflexes have been held comparatively in abeyance. The degree of irritation varies within wide limits, according to the idiosyncrasies of the patient. Sometimes temperamental peculiarities are found to exert an undoubted influence upon the severity of the cough. The non-excitable and phlegmatic are inclined to cough but little, and then only to expel secretions, while people of a distinctly nervous type frequently indulge in prolonged and distressing expulsive efforts which are attended by scanty, if any, expectoration. This relation, however, as to the individual temperament and the character of the cough, does not exist in all cases.

A common conception regarding the cough is to the effect that it is slight in the beginning, and that its subsequent frequency and severity are commensurate with the further advance of the disease. This is far from being the case. The character and frequency of the cough afford no criterion by which to judge of the clinical progress. In fact, bronchial irritation may be decidedly increased in spite of subjective and physical evidences of diminished tuberculous activity, and vice versâ. In other words, the cough may get better as the patient grows steadily worse, or it may become aggravated notwithstanding decided general improvement. It is occasionally true that in dry, dusty climates the bronchial irritation is maintained in the midst of a progressive arrest of the infection. Especial care should be taken in such cases to acquaint the patients with a full knowledge of their exact status, in order that no misconceptions as to their condition may be entertained as a result of a persisting or aggravated cough. In extreme instances it sometimes becomes a choice of the lesser of two evils, in which event the tuberculous element in most cases should take precedence, particularly if there exists any remaining evidence of tuberculous activity. Altitude and dryness are inevitably associated with a degree of variability in temperature, and while this combination is conducive to individual improvement, the bronchial irritation, nevertheless, may remain somewhat aggravated. After the tuberculous process has become arrested demonstrably, this disturbance may be expected in many cases to be mitigated by the equability of the lowlands, the accompanying moisture then being less likely to produce harmful effects upon the underlying disease. Bronchial irritation is often especially pronounced in cases of emphysema, asthma, and dry bronchitis. Upon the other hand, patients with moist bronchitis, on going to high dry climates, sometimes experience a remarkable diminution in the severity of the bronchial disturbance long before the physical signs reveal an

actual improvement in the tuberculous lung. Climatic influences will be considered at length in a separate chapter.

Generally speaking, the cough may vary from a slight clearing of the throat to violent and prolonged paroxysms of expulsive effort. Exclusive of individual idiosyncrasies and temperamental influences, the cough may be said to partake more frequently of a paroxysmal nature in the presence of pulmonary cavities, bronchiectases or pneumothorax, and severe coëxisting chronic bronchitis. The paroxysms occur at intervals and are especially marked in the morning and at night. Change of posture often exerts a striking influence in the causation of violent spells of coughing. This is observed not only upon arising in the morning and retiring for the night, but also when the patient reclines during the day, turns from one side to another in bed, stoops over, or changes the position to any marked extent. A slight amount of physical exercise is often productive of a similar result. The paroxysms are also induced by going from a warm room into the cooler outside air, or upon alternation of heat and cold within doors. Severe paroxysms often take place after eating a very hearty meal, upon exposure to a draft or strong wind, the inhalation of dust, indulgence in hearty laughter, grief or sudden emotion, nervous excitation or alcoholic stimulation. The paroxysms may vary from a few moments to several minutes' duration, during which time the face becomes suffused with a purplish flush, the veins of the head and neck unduly prominent, visible perspiration induced upon the brow, and in some cases involuntary micturition. Vomiting is an unfortunate accompaniment of the cough. It is particularly likely to ensue by virtue of the pharyngeal reflex if the paroxysms follow a hearty meal. This unfortunate symptom often interferes materially with the chances for recovery, on account of the difficulty imposed in maintaining sufficient alimentation. When possible, the patient should be compelled to partake of more food shortly after the cessation of vomiting. It is seldom that a similar result follows the second meal, as the bronchial secretions are evacuated to some extent in the act of vomiting. I have observed that the majority of patients who suffer from this distressing symptom experience their greatest difficulty after the evening meal, having been able to retain their morning and midday nourishment with comparative ease. For such patients, as will be explained later, complete rest after the ingestion of food is essential, with sometimes the addition of cracked ice or cocainization of the pharynx.

EXPECTORATION

Like the cough, the expectoration is a decidedly variable factor in pulmonary tuberculosis. There are presented striking differences in quantity, gross appearance, manner of expulsion, and composition.

The **quantity** may vary from half a dram to over a pint in twenty-four hours. It is believed quite generally that the quantity is slight in early cases, and increases in proportion to the onward progress of the disease. In other words, the amount is supposed to correspond more or less closely to the activity of the involvement and the extent of destructive change. While the expectoration *frequently* becomes more profuse with increasing moisture in the chest, beginning evidences of softening, and the recognition of cavities, this is not invariably the

case. I often find the expectoration profuse when but little moisture can be recognized upon examination, and, *per contra*, but scanty expectoration in spite of widely diffused moist râles, in some instances notwithstanding the existence of considerable cavity formation. A comparatively copious expectoration in the *absence* of such physical signs as would suggest its occurrence may be explained by a coëxisting bronchitis involving chiefly the larger-sized tubes and producing quantities of mucopurulent secretion. It is difficult to account satisfactorily for the absence of cough and expectoration in individuals presenting upon examination the moist bubbling râles or cavity signs incident to an active tuberculous process. The hypothesis of a marked diminution in the sensibility of the bronchial mucosa is scarcely a tenable explanation in all cases, as the expectoration is frequently *nil despite* repeated cough and the existence of moisture in the bronchioles.

The **gross appearance** of the sputum also is subject to much variation in different individuals, its character being dependent largely upon the extent and nature of morbid pulmonary change. In the beginning it is often scanty and somewhat glairy or viscid, consisting mostly of mucus with but little, if any, pus. As the disease advances tiny yellowish or greenish-yellow masses make their appearance. These gradually increase in number and size until the sputum is essentially mucopurulent. The yellowish masses are usually clothed more or less with a glairy mucous coating. Rarely is the expectoration distinctly purulent, save in cases complicated by an open pneumopyothorax, in which event the secretion is similar to the pus of an empyema and sometimes excessive in quantity.

The expectoration from pulmonary cavities is often heavy, apparently homogeneous, and of more solid consistency, sinking to the bottom when deposited in water. This is described as "nummular" sputum, and although usually flattened to some extent, is more or less spheric. It is not always indicative of pulmonary cavities, as this variety of sputum may be present in cases of bronchiectasis.

The expectoration is sometimes flecked with tiny specks of blood or discolored by distinct hemorrhagic streaks. At other times it is reddened homogeneously with bright blood or stained a rusty hue. As a rule, the presence of minute flecks or streaks of blood in the expectoration is of but little significance, as a slight amount may be deposited upon the sputum in its progress through a congested bronchial tube. A thoroughly red-stained expectoration is often regarded as suggestive of its origin from an irritated pulmonary cavity. Dark bloody clots contained in the expectoration, as a rule, are the result of a previous pulmonary hemorrhage, the blood having remained for a considerable time in the bronchial tubes. A rusty expectoration is observed more commonly in cases of tuberculosis complicated with a beginning bronchopneumonia.

The sputum in some instances is light and frothy, showing an abundant admixture of air. This form of expectoration occurs more frequently in cases exhibiting considerable interstitial change, as in fibroid phthisis, old chronic pleurisies, and occasionally in asthma. It is notably increased after administration of the iodids.

The expectoration is sometimes described by the patient as having a somewhat sweetish taste and of nauseating character. There is seldom

any unpleasant odor to the sputum itself, save in the presence of pulmonary cavities, bronchiectasis, fetid bronchitis, or gangrene.

Finally, it should be borne in mind that it is impossible to form accurate conclusions as to the character of the affection from the gross appearance of the expectoration, as the sputum in some cases of chronic bronchitis is strikingly suggestive of tuberculosis. Furthermore, it frequently happens that cases of pulmonary tuberculosis with complicating chronic bronchitis and bronchiectasis exhibit the characteristic sputum of such conditions, especially the abundant quantity and the separation upon standing into distinct layers.

The **expectoration is expelled** with apparent ease in some cases and with comparative difficulty in others. This is dependent to some extent upon the pathologic change in the pulmonary tissues, the degree and nature of bronchial disturbance, and the temperament of the individual.

In cases with abundant moisture in the bronchial tubes, with pronounced softening or beginning cavity formation, the expectoration is often raised with but little effort. This is also true whenever the coëxisting bronchitis is of the moist variety. Expectoration is conspicuously easier in phlegmatic individuals than in the neurotic.

In cases of dry bronchitis with marked bronchial irritation the secretion is not only less copious, but decidedly more difficult to raise. The expectoration from cavities and bronchiectases may be attended with considerable expulsive effort. In some cases this is attended with violent paroxysms, while in others the cavities are emptied, almost *in toto*, by mere change of posture and beginning cough. In cases of pneumopyothorax with free opening into a bronchial tube there is usually but little difficulty in expelling the secretions.

In a consideration of the **composition** of sputum, chief importance attaches, of course, to the tubercle bacillus, but the presence of elastic fibers, streptococci, pneumococci, staphylococci, and influenza bacilli is of great practical interest. No especial clinical importance relates to the detection of pus-cells or blood-corpuscles, detritus, or epithelia from the mouth, trachea, or even from the pulmonary alveoli.

It is quite impossible to infer a tuberculous nature of the condition from the general appearance of the sputum. It is unsafe to hazard an opinion as to the presence of bacilli by virtue of the purulent nature of the expectoration, or as to their absence from its watery or serous appearance. *Neither* is it *safe* to *assume* their presence in individual cases, no matter how *apparently conclusive* may be the *subjective symptoms* or *physical signs*. *Long-continued examinations* of the sputum not infrequently *fail* to *disclose bacilli* in *such cases*, while they *often are detected* in the sputum of individuals *presenting no physical signs whatever*. Failure to find the bacilli after searching investigation is explained by delay in the ulceration of the tubercle deposit, and perhaps in some cases by absence of communication of the infected area with a bronchial tube.

The lack of conformity between the physical signs and the bacteriologic findings is sometimes remarkable. Attention will be called later to the existence of very suggestive subjective manifestations and almost conclusive physical signs in pulmonary syphilis, influenza, and anthracosis, without the demonstrable presence of bacilli.

The description of the tubercle bacillus has been given in an earlier

chapter, and instructions have been detailed as to the technic of sputum examination. It is only necessary to emphasize again the importance of selecting, when possible, one of the tiny yellowish or greenish-yellow opaque lumps from the expectoration and of securing a thin smear upon the cover-glass. It is a common fault with beginners to overstain.

In collecting specimens of sputum for examination explicit instructions should be given to the patient not only as to the thorough *cleansing* of the bottle and cork, but also concerning their *sterilization*. It is desirable that the sputum should be obtained in the morning before the ingestion of food, and that the mouth and throat should be thoroughly rinsed with a saturated solution of boric acid. This is particularly important when search is to be made for other microörganisms than the tubercle bacilli.

The elastic fibers are often recognized in the sputum, as they are not destroyed by the softening process in the lungs. Bacilli sometimes are found, however, before the elastic fibers make their appearance. The latter may be detected also in connection with pulmonary abscess and gangrene of the lung. They are commonly recognized by boiling an equal quantity of the sputum with a strong solution of potash or soda, followed by complete sedimentation.

In some cases the influenza bacillus is a factor of especial importance, irrespective of the presence or absence of tubercle bacilli, as will be described under the subject of Diagnosis.

The sputum of patients who present extremes of fever, sweating, and other manifestations of severe constitutional disturbances often contains streptococci, staphylococci, and pneumococci. The recognition of these micro-organisms in such cases is a matter of the utmost consequence, as will be seen in the chapters devoted to Mixed Infection and Specific Medication.

CHAPTER XVIII

PAIN, HOARSENESS, AND DYSPNEA

PAIN

Pain in the chest is by no means a constant feature of pulmonary tuberculosis, although many believe that it is almost sure to develop at some time in the course of the disease. There is no relation between this symptom and the nature or extent of the tuberculous involvement *per se*. A more or less active pulmonary invasion may exist for years without the slightest admission of pain on the part of the patient. Upon the other hand, complaint may be made by some individuals in whom the physical signs are exceedingly slight. There is no special reason why involvement of the pulmonary tissue *alone* should produce pain, even should the destructive change extend to the formation of cavities.

Pain in the chest developing in the course of pulmonary tuberculosis is almost never referable to the damaged lung tissues, but results invariably from coëxisting intrathoracic complications. It may accom-

pany acute bronchitis, any form of pleural invasion, initial pneumothorax, intercostal neuralgia, and the pulling upon the diaphragm incident to violent paroxysmal cough, or it may exist simply as an expression of a neurotic disturbance.

The pain attending **acute bronchitis** complicating pulmonary phthisis is usually felt in the front of the chest, extending from the manubrium downward along the sternum. It may vary from a feeling of rawness with oppression to a sensation of actual pain. In such cases it is often associated with soreness in the lateral regions of the chest, owing to the frequent distressing cough incident to the bronchial affection.

Pain resulting directly from **pleuritic involvement** is always referred to the affected side of the chest. A pleurisy, however, may exist upon one side, devoid of any sensation of pain, while, as a result of *other* causes, complaint may be made with reference to the opposite side. While pleurisy is not invariably attended by physical discomfort, the pains, if present, are more or less sharp and stabbing in character. They are excited particularly upon deep inspiration and cough, and relieved by immobilization of the ribs. If the pain be at all considerable, the respirations are interrupted in character and markedly restrained. The pain is not referred in all cases to the precise site of the pleural involvement. I have repeatedly recognized the friction rub of a dry pleurisy, and yet have been unable to obtain, either during forced respiration or cough, any admission of pain in the vicinity of the evident pleural involvement. The pain may be absent entirely or referred to an inferior point in the chest, even to the extreme lower margin of the ribs. Occasionally I have found the pain upon cough and respiration ascribed to the lumbar region and lower abdomen. As is well known, moderately large pleural effusions may exist without the slightest subjective evidence of their presence.

The pain of an **initial pneumothorax** resulting from perforation of the pleura is usually of a most severe and excruciating character, and attended by symptoms of profound prostration or collapse. In such cases the pain may not be referred to a single point, but may extend throughout the entire affected side. A frequent site, however, is in the region of the heart. Accompanying the pain in the side is the familiar oppression or "air-hunger," resulting from the sudden collapse of the lung before its fellow of the opposite side has been able to adjust itself to the radically increased respiratory demand. It should be remembered, however, that pneumothorax may occur without causing pain or any other pronounced subjective symptom. Many times I have been impressed by this striking phenomenon, which is contrary to the usual conception regarding the clinical onset of pneumothorax. It is noteworthy that many such conditions have developed while the patient was lying quietly in bed without exhibiting severe or distressing cough, and not having experienced muscular strain of any kind.

Paroxysmal cough, resulting from more or less extensive cavity formation, bronchiectasis, and pronounced bronchial irritation is frequently responsible for the production of pain. This is usually referred to the lower lateral portion of the chest, and very likely is caused by the increased tension at the attachment of the diaphragm.

Intercostal neuralgia may exist among pulmonary invalids as in those who enjoy ordinary health. It is present chiefly in the region of the nipple and in the middle or lower zone of the thorax. Like the

pain of pleurisy, it may produce a decidedly restrained respiration for the time being, but the absence of fever and physical signs usually suffices for its accurate determination.

Finally, complaint of pain is made by a type of individuals who exhibit evidences of a nervous temperament, and often with a well-marked functional derangement. The pain may not be localized definitely, and even may vary in its location during short intervals. If limited to a single region, it is often stated to exist in the lower portion of the thorax, far removed from the site of any recognizable tuberculous lesion. Frequently the pain is referred to the region of the liver. Sometimes it is said to be present near the lower angle of the scapula or in the region of the nipple, but rarely at the apex. When ill defined and vague in character, it usually occurs more as a hyperesthesia of the skin than as actual pain, and is said by the patient to be increased upon percussion or pressure with the stethoscope.

VOICE SYMPTOMS

Alterations in the voice are of considerable frequency, and vary from slight temporary changes in quality and intensity to marked hoarseness or complete aphonia.

Hoarseness is sometimes one of the early symptoms of tuberculosis, but it may appear at any time during the course of the disease or be entirely absent. Change in the character of the voice may be so slight as to be scarcely appreciable, or so great as to effect a complete transformation of tone, rendering the sound harsh and discordant.

The chief interest attaching to hoarseness as a symptom of consumption relates to its precise cause and duration. By far the most important factor in its production is a coëxisting tuberculosis of the larynx. By virtue of the general anemic condition of the larynx, a paresis of the adductor muscles may account for the early hoarseness long before a definite suspicion is entertained of either a laryngeal or a pulmonary tuberculous involvement. Somewhat later an infiltrative process may occasion a slight tumefaction in the posterior commissure, preventing complete adduction of the vocal bands, and producing a distinct change in the quality of the voice. The tuberculous infiltration may extend to the vocal bands themselves, producing thickening and congestion, or to the muscles which control the movements within the larynx. Finally, distinct ulcerations may take place along the free margin of the vocal bands. (For further discussion of Laryngeal Tuberculosis see Complications.)

Hoarseness is frequent in the course of pulmonary phthisis in the absence of tubercle deposit within the larynx. It may occur as the result of complicating acute, subacute, or chronic laryngeal catarrh, producing congestion and thickening of the bands, precisely as in non-tuberculous individuals. The hoarseness may be intensified for brief periods by the presence of retained secretions upon the vocal bands, preventing their perfect apposition. Changes in the quality of the voice, due to this cause, disappear in part after the act of coughing or clearing the throat, and particularly when the larynx has been thoroughly cleansed by a spray. Hoarseness may be experienced as a result of muscular fatigue from the overuse of the voice following loud speaking or prolonged reading.

In the absence of definite visual changes recognizable within the larynx, the quality and intensity of the voice become impaired in many consumptives toward the later stages of the disease, on account of the extreme systemic debility. In such cases the hoarseness may be regarded as an expression of the general prostration, as in other severe constitutional diseases.

Paralysis of the cords may result from the implication of a recurrent laryngeal nerve in the pleuritic thickenings and adhesions at the pulmonary apex.

It is almost unnecessary to state that the degree of hoarseness, whatever its cause, offers no possible criterion of the nature or extent of the pulmonary infection. As a matter of fact, a decided amelioration of the phthisical condition, as shown by the physical signs, sometimes follows the onset of laryngeal tuberculosis. As a general rule, a gain in the local condition takes place commensurately with general improvement.

DYSPNEA

Changes in the frequency of the respirations are more or less constant, though subject to marked variation in individual cases. The quickened rate may extend from a slightly accelerated breathing to true dyspnea. The latter is usually associated with cyanosis, and upon trifling exertion the auxiliary muscles of respiration are called upon to respond to the respiratory needs of the patient.

Like other symptoms, dyspnea has no fixed relation to the extent of morbid change within the thorax. It is common to observe patients with an astonishing destruction of lung tissue and apparently an extensive reduction of respiratory area with but little, if any, shortness of breath. Others may display but slight physical evidence of disease and yet exhibit a marked degree of respiratory embarrassment. Some, in spite of a very rapid pulse, boast that they are as "long winded" as in former health, while others have but limited respiratory capacity, notwithstanding the fact that the pulse may be slow and of excellent quality.

Neither fever nor anemia offers any reliable criterion by which to form conclusions regarding the dyspnea of consumptives. In general, however, certain conditions are found to exert an unquestioned influence in its causation. One of the most important of these is a material diminution of the respiratory surface. In this event the essential consideration is not so much the extent of the respiratory limitation as the suddenness of its development. The time in which the respiratory capacity is reduced constitutes the fundamental element in determining the extent of the resulting dyspnea. Thus many patients may be observed with numerous areas of impaired lung as a result of prolonged pulmonary tuberculosis, or with one lung rendered entirely inactive by a slowly developing pleural effusion, or, still further, with wonderfully diminished bilateral respiratory capacity as a result of chronic interstitial pneumonia, and yet suffering but slight inconvenience from shortness of breath. The reason is apparent from the fact that the obliteration of the respiratory surface takes place so slowly that the unaffected portion of lung is able to adapt itself to the changed conditions, and respond in a measure to the increasing needs which are imposed upon it. To illustrate the impossibility of perfect adaptation and response when the respiratory function is embarrassed by the sudden involvement of large

pulmonary areas, it is only necessary to cite the alarming dyspnea incident to pneumonia, and the air-hunger with collapse resulting from sudden pneumothorax. Therefore the dyspnea of pulmonary tuberculosis, while produced in part by the consolidation or destruction of lung tissue, yet in some cases may correspond but little to the extent of pathologic change.

Pulmonary invalids often ask for an explanation of their dyspnea, the issue involved in the mind of the patient being a determination as to whether the shortness of breath is due to the pulmonary involvement, to the heart, or to other conditions. It is sometimes difficult to arrive at a satisfactory conclusion as to the precise relation of the several factors jointly responsible for its production. A weak and rapid heart is unquestionably an important cause in many cases, especially if renal disturbances coëxist. Fever is known to make the respirations more shallow and more frequent. Profound anemia is associated with shortness of breath on account of the resulting deficient oxygenation. Upon this theory alone it is hard to explain the dyspnea of tuberculosis, for the examination of the blood rarely shows a change proportionate to the pronounced outward manifestations of anemia.

The shortness of breath is often more noticeable in neurotic than in phlegmatic patients, and is intensified by excitement or mental emotion. Many patients are observed who experience not the slightest respiratory embarrassment so long as they are at *rest*, but who suffer from distressing shortness of breath upon slight exertion. I do not regard this feature of itself as a contraindication for moderate altitudes, provided the pulse is satisfactory and evidences of general improvement are established, but rather as an emphatic indication for absolute rest regardless of location.

The dyspnea of tuberculosis is, of course, subject to considerable variation according to the coëxisting complications.

In chronic bronchitis the increased frequency of respiration is induced to a large extent by the obstruction occasioned in the finer bronchioles by the thickened mucous membrane and the presence of secretion. The progress of air *into* the pulmonary alveoli is thus obstructed to some extent, and its exit even more, as the normal act of expiration is essentially passive in character. The expiratory effort is exerted largely upon the bronchioles, thus throwing additional strain upon the pulmonary alveoli. This, in connection with coincident nutritional change, produces in time an unavoidable emphysema.

In proportion as emphysema develops, either with or without asthma, will the severity of the dyspnea increase. This is also intensified by the extension of small areas of bronchopneumonia, whether of tuberculous or of inflammatory origin.

Dyspnea following a pulmonary hemorrhage is attributable in some instances to the development of septic aspiration pneumonia. The dyspnea is increased moderately in pleural effusion, and usually to an extraordinary degree by the onset of pneumothorax.

It has been mentioned that in acute miliary tuberculosis of pneumonic type the dyspnea is out of all proportion to the physical evidences of the disease. This would suggest that the shortness of breath is not to be accounted for entirely by the diminution of respiratory area, but to some extent by the irritation of the terminals of the vagus by reason of widely disseminated miliary tubercles. Pressure upon the vagus by enlarged bronchial glands may produce the same result.

CHAPTER XIX

FEVER

Fever, by virtue of its overwhelming prognostic significance, surpasses in importance all other symptoms of consumption. Persisting elevation of temperature furnishes more reliable evidence upon which to base unfavorable conclusions regarding ultimate success than any other clinical feature in the course of pulmonary tuberculosis. A continuous fever is an insuperable obstacle to recovery. The development of fever is known to be entirely independent of the physical signs, the stage of the disease, or the nature and extent of pathologic change. Most extensive areas of active tuberculous infection may exist without any appreciable elevation of temperature. A severe constitutional disturbance, however, may accompany a slight, inactive tuberculous process. Many attempts have been made to offer a satisfactory explanation of the origin of fever, to account for its presence or absence in different cases and in the same individual under varying conditions, to classify arbitrarily its several forms, and to ascribe to particular types a fixed correspondence with certain pathologic and bacteriologic conditions. Thus far such efforts have not proved entirely convincing from a clinical standpoint. It is difficult to explain authoritatively why it is present in some cases and not in others; why the same patient may exhibit an elevation of temperature for weeks, to be followed by an unexpected decline for variable periods; why in those afflicted it is absent in the morning, only to rise in the afternoon; why there is no relation between its presence and the various clinical stages of the disease, and why it should exhibit so striking a dissimilarity in various cases, rather than conform to the characteristics of a single type. No effort will be made to explain the precise manner of its production and the diversity of its exhibition. Practical interest at this time attaches more to the clinical manifestations of fever and its prognostic and therapeutic significance than to a detailed study of the influence of the tubercle bacillus and the microörganisms of mixed infection. Suffice it to say that the fever may be traced directly to the tubercle bacillus as well as to the accompanying bacteria of mixed infection. Among the latter the streptococcus, staphylococcus, and pneumococcus are especially conspicuous in its production.

The fever attributable to the tubercle bacillus is often of minor importance in comparison with that occasioned by other microörganisms. That the tubercle bacillus may serve as at least a contributory agent in its development is suggested by the fever of pure miliary tuberculosis and the rise of temperature following injections of tuberculin.

The fever of consumption may be assumed to be due primarily to the absorption into the circulation of certain toxic products. The height of the fever would naturally suggest the approximate concentration of the poisons in the blood or body-fluids. The degree of saturation of the circulatory and tissue fluids would ordinarily be regarded as more or less commensurate with the area of the primary focus of infection, the degree of activity of the tuberculous process, the extent of degenerative change, and the capacity for absorption on the part of the individual.

While these factors in the absorption of toxic products may be accepted in their general application, there exist certain modifying conditions, capable in some instances of producing diverse results. Thus the absorption from a large area of infection may be much less than from a small focus, by virtue of changes in the tissue immediately contiguous to the tuberculous process, serving effectually to impede peripheral absorption. These changes may relate in some cases to the impaired absorptive capacity or to an obliteration of the finer blood-vessels. At other times a barrier to absorption may be established through the concentration of the poisons in the tissues immediately adjacent to the infected area. Again the degree of activity and the character of pathologic change may not be correctly represented by the degree of fever. Rapidly advancing caseation is often unattended by fever, provided there is ample exit for the products of disorganization through free communication with a bronchial tube. Pulmonary cavities may be unaccompanied by fever, although the destructive change is quite extensive. This is particularly true if the excavation is surrounded by thickened, indurated tissue, affording scant opportunity for absorption. Further, the absorptive power of individuals varies according to their age, the state of the general circulation, and the degree of stasis in the immediate neighborhood of infected areas. Finally, the specific nature of the microörganisms constituting the secondary infection influences to a considerable extent the character and degree of fever. These considerations suggest a partial though superficial explanation of the vagaries of temperature in consumption, but the more complete elaboration of their production is left to others.

Irrespective of its precise origin, which may be incapable of authoritative explanation, the fact remains that the fever of phthisis is a decidedly variable quantity. It is often present in the early stages, only to disappear later in the disease. This is attributable in part, though not entirely, to the enforced rest, which is insisted upon after the patient comes under competent observation. As a rule, an excessive elevation of temperature is observed only after the tuberculous process has become well advanced, or in the presence of inflammatory or septic complications. The afebrile state of some individuals may be interrupted temporarily by various causes, as an intercurring influenza, an acute digestive disturbance, the development of bronchopneumonia, pleurisy, or pneumopyothorax, and by extension of the tuberculous process to hitherto uninfected areas. Ephemeral elevations of temperature are observed as a result of personal indiscretions relating to injudicious exercise, fatigue from any cause, and nervous excitement. In some patients a short walk or sitting up in bed, the entertainment of callers, card-playing, mental irritation, grief, anger, or an absorbing book are sufficient to produce moderate fluctuations. Fever is often present during the period of menstruation, although a normal temperature is exhibited at other times. Noticeable differences of temperature are noted according as the record is taken out-of-doors, after physical exercise, the swallowing of hot drinks, the ingestion of ice-cream, or the holding of bits of ice in the mouth. The temperature taken with the patient in the cold air is almost invariably lower than within doors. It also is elevated perceptibly after moderate exercise, but is difficult of recognition unless taken by the rectum. In mouth-breathers particularly it is almost impossible to obtain an accurate record after exercise on

account of the appreciable cooling of the buccal and lingual membrane incident to exposure to cold air. The mouth should be closed during the entire time that the thermometer remains in position. An interval of at least five minutes should elapse before this is removed, else the record becomes extremely unreliable.

Rest, both physical and nervous, is almost a *sine qua non* in the effort to effect a continued reduction of fever. The maintenance of the recumbent position in bed during the twenty-four hours of the day is often attended with remarkable results in far-advanced cases.

Without attempting too great refinement in a classification of the various types of fever observed among consumptives, it perhaps is sufficient to enumerate briefly the following varieties:

The first class comprises patients whose temperature is normal in the morning and rises to the neighborhood of 100° F. or 100⅖° F. in the afternoon. Such invalids are frequently unaware of the existence of fever, and often deny this possibility most emphatically until convinced by the use of the thermometer. There may be no flushing of the cheeks, no greater sense of warmth, or other evidence of discomfort from the increased body-heat. Others present the history of slight chilly sensations preceding the rise of temperature, followed by flushing and burning of the cheeks, dryness of the mouth and lips, lassitude, slight dyspnea, and more or less actual discomfort.

A second class may be described as exhibiting an intensification of the fever of the preceding type. The temperature rises in the afternoon to 102° F. or 103° F., and recedes in the morning to the neighborhood of 100° F., or sometimes to normal. The fever is frequently preceded by chilliness, and attended by other unpleasant sensations, but not invariably. Patients are usually conscious of the elevated temperature, and sometimes experience considerable physical discomfort, as headache, disagreeable sense of warmth, anorexia in the afternoon, and general indisposition. These types of fever may be present during any stage of consumption.

In a class of cases the fever may assume still another clinical form. In the morning it is considerably below normal, beginning its ascent more or less abruptly in the middle of the day, and rising until evening to 103° F. or 104° F. The fever of this class is more likely to be preceded by a distinct chill, or at least by pronounced chilly sensations, than that of any other variety. As a rule, the patient is exhausted in the morning, pale or somewhat cyanotic, with marked coldness of the hands and feet. The fall of fever is likely to be associated with drenching sweats, which may occur at any time during the night, but more particularly in the early morning. This is known as the fever of absorption or mixed infection, and is described as *hectic*, corresponding to the so-called *septic fever of surgeons*. It has been thought to be attended almost constantly by softening or rapidly advancing excavation, but such is not always the case. I have repeatedly seen this variety of fever, even in early cases, without the slightest suggestion, upon examination, of cavity formation or softening, while patients with advancing infection and excavation often fail to display this type of fever.

Another variety of fever is characterized by a continuous high elevation of temperature at all hours of the day. There may be a remission of one or two degrees in the morning, but the recession is rarely to normal. The fever of this class is accompanied almost invar-

iably by increasing dyspnea and cyanosis, and is frequently exhibited by patients suffering from an acute bronchopneumonic complication. In some instances these cases from the beginning are found to partake of the characteristics of acute pneumonic phthisis. It is not altogether unusual to observe the development of an acute pneumonic extension of the tuberculous process in patients previously manifesting a chronic type of consumption. A patient who for years had been afflicted with pulmonary tuberculosis exhibiting subjective and physical evidences of a quiescent infection experienced, without warning, a severe rigor, followed by an abrupt rise of temperature to 104⅖° F. Examination of the lungs shortly disclosed a distinct pneumonic consolidation in the left front. At no time afterward did the temperature recede in the morning more than one or two degrees, while the dyspnea increased, emaciation became rapid, and cyanosis with exhaustion were increasingly apparent. At the end of one week the physical evidences of softening were recognized in the consolidated lung, and expectoration, which previously had been absent, became very profuse. At the time of his death, which took place three weeks after the initial onset of the pneumonic extension, cavity signs were readily detected.

Sometimes cases are observed in which the temperature is decidedly irregular. The chief clinical characterization, as far as fever is concerned, may relate to an elevated temperature in the morning, followed by an evening remission. In some cases, however, this so-called inverse type of fever may be followed for several days by morning remissions and evening exacerbations. Such irregularities of temperature may develop in patients who previously exhibited no fever whatever. This suggests the possibility of a general miliary infection supervening in the course of the pulmonary disease. The fever may be associated with vague, indefinite symptoms of malaise, languor, indisposition, and digestive disturbances simulating typhoid, or it may be attended by headache, pain in the back of the neck, delirium, stupor, and motor symptoms of meningeal tuberculosis. It may also be accompanied by cough, with slight expectoration and a disproportionate dyspnea and cyanosis, the physical signs being those of a widely diffused bronchitis. This latter combination of symptoms is highly suggestive of a miliary infection with predominant manifestations in the lungs.

Other types of fever have been mentioned by various observers, and a fixed clinical significance attached to the respective varieties. A comparison of the forms above enumerated is sufficient to convince one of the obvious difficulty in discriminating sharply between some of these clinical types. Further efforts directed toward a conventional classification lead to increased confusion. Summary conclusions as to unvarying pathologic association are not warranted by the results of clinical observation. It must be remembered that the essential consideration in the production of fever is the entrance into the circulation of the toxic products, and that the extent of their absorption does not always correspond to the character of morbid change. It is not always easy to distinguish the exact nature of the secondary infection. In some cases streptococci are found in abundance in the sputum, as are also the staphylococci, pneumococci, and other microörganisms. Examinations of the blood may disclose the particular type of septicemia present, as may also examinations of the pleural exudate.

Not infrequently the sputum, collected in sterile bottles after thorough cleansing of the mouth before the ingestion of food, has shown numerous streptococci and other microörganisms, although not the slightest clinical evidence of sepsis had been established. On the other hand, many patients have displayed the characteristic temperature of mixed infection, with associated chills and sweats, without the recognition of secondary microörganisms in the sputum. This subject will be considered under Mixed Infection.

CHAPTER XX

EMACIATION AND LOCAL OBJECTIVE SYMPTOMS

EMACIATION

Loss of weight is one of the important symptoms of consumption. It bears several definite relations to the tuberculous process. Emaciation, with corresponding impairment of the general resistance, renders the patient distinctly more susceptible to the original tuberculous invasion. The infection once established, contributes almost unavoidably to a further loss of weight. Finally, the only rational method of securing an ultimate arrest of the tuberculous process is the maintenance of an improved nutrition. On account of these established relations between the weight and the pulmonary condition it is easy to appreciate the overwhelming importance of judicious superalimentation. With but few exceptions does the emaciation go hand in hand with an advancing activity of the tuberculous infection. It is true that some patients exhibit physical evidences of rapidly extending pulmonary disease without displaying for a time any considerable impairment of body weight. Occasionally I have noted wide-spread involvement of the lungs with extensive destruction of tissues in very corpulent individuals, but such instances are decidedly exceptional. Rarely are patients fortunate enough to secure an arrest of the tuberculous process without the attainment of greatly improved nutrition. If so, it is found, upon investigation, that success, as a rule, results *not after an attempted failure* to increase body weight, but *despite* the lack of any effort in this direction. In other words, the patient possessing well-marked powers of resistance chances to secure the arrest of an incipient infection without being compelled to resort to a method which is invaluable to the majority of cases. It may be added that patients recovering from consumption without manifesting gain in weight are almost invariably free from fever and have not displayed any appreciable *loss* of their *average* weight.

The relation of fever to general nutrition is of vast significance, the loss of weight usually corresponding to the height and persistence of the temperature elevation. This relation exists not only because of the impaired appetite and digestion, but also by virtue of the fact that both the fever and the emaciation are directly dependent upon the absorption of toxic products. As long as the fever continues it is

extremely difficult to overcome the depraved nutrition even to a slight extent.

The emaciation relates first to the loss of subcutaneous fat, but this does not obtain to an equal degree in all parts of the body. In some individuals the face retains surprisingly its normal contour, while the limbs and body become distressingly thin. In other cases the configuration of the face is distinctly changed, the features assuming a characteristic drawn and pinched appearance, while the outline of the limbs is not proportionately affected. In regaining weight the improved condition is sometimes noted in the face without appreciable change in the body or limbs, while in others the face is the last to exhibit improved nutrition. It is well to observe carefully in all cases the appearance of the neck and hands, the former often showing in a strikingly impressive manner the effect of advancing emaciation.

As the flesh is regained there is a noticeable tendency toward the accumulation of adipose tissue over the abdomen and hips. The increased weight is rarely distributed with impartiality over the entire body. This is due largely to the lack of exercise and the consequent deficient muscular development. In fact, the emaciation is occasioned in part by the atrophy of the muscles from disuse, and with returning weight the limbs, by virtue of the enforced rest, fail to assume their normal contour, the superabundant fat then being accumulated over the abdomen.

LOCAL OBJECTIVE SYMPTOMS

The local manifestations pertaining to pulmonary tuberculosis which are not at the same time subjective in type are comparatively unimportant. They may be said to constitute matters of clinical interest rather than of especial practical significance. A few of these symptoms are perhaps worthy of some allusion.

One of the most striking phenomena is the frequent changed appearance of the ends of the fingers. The peculiar contour of the terminal phalanges has been described as "clubbed," and is believed to be characteristic of tuberculosis. This in a measure is quite incorrect, as in *uncomplicated* pulmonary tuberculosis it is rare to observe genuine clubbing of the finger-tips. Care should be taken to discriminate between the so-called clubbing of the fingers and the marked forward incurvation of the nails. Properly speaking, the term "clubbed fingers" refers to a pronounced thickening of the terminal phalanges referable entirely to the soft parts, without change in the shape and size of the nail. This is not altered in any material respect, but the ends of the fingers give the appearance of being shortened and broadened. The nails are almost invariably perfectly straight and but little cyanosed. This type of finger is found in connection with chronic or fetid bronchitis and bronchiectasis, either existing alone or complicating tuberculosis. The change which is more definitely characteristic of consumption is the *long*, slender, and tapering finger, devoid of any suggestion of thickening, but with pronounced incurving of the nails, which are usually somewhat cyanosed. In pulmonary tuberculosis it is not uncommon also to note long, slim, and narrow hands, with slender but non-tapering fingers, both with and without incurving nails.

The skin of the tuberculous patient is usually dry, although the hands are often cold and clammy. This element of dryness is char-

acteristic of the hair and nails, which are also brittle. As emaciation progresses the skin becomes somewhat wrinkled; as anemia increases

Fig. 2.—Drawings of hands of a pulmonary invalid, illustrating the slight characteristic clubbing of the terminal phalanges, without curving of the nails. Note lateral and antero-posterior thickening.

it is more sallow or even cachectic, and with advancing cardiac or respiratory embarrassment it is more cyanosed and sometimes edematous.

Cyanosis and edema will be alluded to under Symptoms Referable to the Circulation.

The facial aspect and *complexion* may vary more or less according to the particular type of the tuberculous disease. In those with pronounced lymphatic involvement the features are coarse, the nose broad, the lips thick, the general contour of the face somewhat gross, and the complexion

Fig. 3.—Drawing of hands of a pulmonary invalid showing the oft-noted slight incurving of the nails, with characteristic tapering of the fingers both laterally and anteroposteriorly.

muddy. In the distinctly phthisical type the skin is often extremely fair, with the subcutaneous veins especially prominent, and sometimes the face suffused with a hectic flush.

A not infrequent condition is the browish-yellow, dry, scaling rash of pityriasis versicolor, most abundant upon the anterior portion of the chest or abdomen.

Upon percussing the anterior portion of the chest tiny fibrillary contractions of the underlying muscle are sometimes observed. In others an undulatory wave is transmitted from the point of percussion

Fig. 4.—Drawing of the long thin hands of a pulmonary invalid, showing slender, non-tapering fingers with incurving nails.

to the farthest extremity of the muscle. This is regarded as a phenomenon of degeneration, and is produced by the hyperirritability of the atrophied muscle.

CHAPTER XXI

CIRCULATORY DISTURBANCES

The symptoms attributable to the circulation observed in pulmonary tuberculosis are acceleration of the pulse in the absence of recognized cardiac lesions, changes in the heart itself, including its dislocation, symptoms of resulting stasis, and, finally, pulmonary hemorrhage.

Increased rapidity of the pulse-rate due to various causes may occur at any period during the course of the disease. It is often noted in very early stages, and when unassociated with other symptoms or physical signs is frequently regarded as indicative of a threatening tuberculous invasion. The truth is that in many such instances the patient is already the subject of tubercle deposit, the evidences of which thus far have been incapable of precise determination.

The acceleration of the pulse may vary from a slightly increased frequency to the point of genuine tachycardia. In some cases the rapid pulse-rate is temporary in duration, being subject to considerable variation, according to external conditions. While gradual improvement is sometimes observed in the absence of exciting causes, it often happens that the increased rapidity persists indefinitely. This symptom, when present, constitutes one of the most important features of pulmonary tuberculosis. It possesses vast prognostic import, and suggests more imperatively even than fever the necessity of absolute rest. It often occurs independent of fever or in the absence of pronounced physical signs. When occurring in very early stages, it rarely is associated with an acceleration of respiration. Many patients, however, with considerable elevation of temperature and marked evidences of active tuberculous infection, fail to exhibit this symptom to any extent.

The pulse is usually soft and easily compressible, the blood-pressure apparatus registering a low arterial tension in the majority of cases. In some, however, it is full and bounding, with associated cardiac excitability, the exaggerated heart action at once being recognized by the stethoscope. This form is more frequently observed either in connection with fever incident to inflammatory disturbance or in a few highly excitable and neurotic subjects. Not infrequently the heart appears unduly stimulated, the sounds being noticeably louder and the impulse intensified to such an extent as to produce a distinct rise and fall of the stethoscope with each pulsation. The soft and easily compressible pulse is also noted in connection with more or less waste of nutrition and general exhaustion.

Acceleration of the pulse is an especially common symptom among young pulmonary invalids, in whom it is subject to much variation. It is found to be increased by slight exercise or nervous excitement. It may be produced by card-playing, animated conversation, emotion, or the ingestion of a hearty meal. The pulse in such cases is usually slow in the morning, but suddenly becomes accelerated upon the advent of exciting causes. In innumerable instances I have found not only that rest is necessary in order to reduce this disturbance to a minimum, but a degree of isolation as well, even to the exclusion

of the few social diversions permitted to pulmonary invalids. As a result of the disturbed systemic circulation, engorgement of the liver not infrequently takes place. A persisting enlargement of this organ from passive congestion is undoubtedly of very unfavorable prognostic import.

In some cases the increased pulse-rate may be extreme without being associated with dyspnea or other subjective symptoms sufficient to excite the attention of the patient. In other instances there are restlessness, dyspnea, cardiac palpitation, and inability to sleep. I have in mind the case of a woman, thirty-five years of age, who came to Colorado in 1899 with moderate involvement of each lung and but slight elevation of temperature. On account of extreme prostration she was accompanied upon her journey by her attending physician. Upon their arrival I was informed that for many weeks it had been necessary for her to maintain the recumbent position on account of a very rapid pulse with associated distressing symptoms. The pulse remained from 160 to 180 for several weeks, although there was no cardiac lesion. It was impossible for the patient to sit up without alarming symptoms of collapse. Liquid food was taken through a drinking tube. Emaciation was extreme, the patient weighing but seventy-five pounds. Heart stimulation was employed tentatively, but relief was obtained chiefly through the cautious administration of opiates. During the four years that she remained under my observation she exhibited a progressive improvement, gaining eighty pounds in weight, securing a complete arrest of the tuberculous process, with entire relief of the tachycardia, although residing in a distant part of the State at an altitude of 7500 feet—one-third higher than Denver.

Increased frequency of the rate usually fails to respond to the employment of therapeutic remedies calculated to slow the pulse, but often yields to the influence of rest and non-depressing sedative agents.

Acceleration without cardiac involvement may be due in part to fever, anemia, the toxins incident to the tubercle bacilli and mixed infections, pressure upon the vagus from tuberculous mediastinal glands, and reduced intra-arterial pressure. I have been impressed by the uniform diminution of blood-pressure exhibited by my patients in a series of examinations recently made. It would seem that to some extent this condition may exist as a partial factor in the production of an increased pulse-rate.

Irregularity of the pulse during the course of consumption occurs comparatively seldom in connection with increased frequency. Occasionally it may exist, however, as may also pronounced slowing of the pulse. At this time I am attending a lady in middle life who is securing a very satisfactory degree of arrest following extensive active involvement of both lungs, with considerable excavation. For months there have been an absence of fever, marked diminution of cough and expectoration, pronounced gain in weight, and evidences of an extensive fibrosis. Of late she has developed a disturbing irregularity of the pulse, which has also become very much slower than formerly, and is ranging in the neighborhood of 40. I have been able to recognize no lesion of the heart, and the cause of the bradycardia remains purely a matter of conjecture, although the probability of myocarditis is apparent.

Weakness of the heart may develop as a result of the general exhaus-

tion, for excessive loss of weight, fever, and anemia inevitably produce anatomic changes in the heart muscle. In cases of profound toxemia marked degenerative changes are likely to result. Many observers, following Brehmer's example, have reported a diminution in the size of the heart of phthisical patients.

Endocarditis is not especially uncommon as a complication of pulmonary tuberculosis, in many instances the condition resulting through the influence of secondary infection. In addition to the actual valvular changes incident to the endocardial involvement, a systolic murmur is often detected in the region of the pulmonary valve, especially if anemia is profound. An accentuated second sound is exceedingly common on account of the obstruction to the circulation in the pulmonary artery and the consequent increased arterial pressure. As an indirect result of the obstructed blood-current in the pulmonary artery eventual dilatation of the right ventricle may ensue, and tricuspid regurgitation may also develop. The embarrassed pulmonary circulation is seen more frequently in cases of considerable pneumonic consolidation, extensive fibrosis, and emphysema, as in these conditions especially are the demands upon the right heart more insistent.

Varying degrees of stasis in the lesser circulation arise as the direct effect of well-defined cardiac disturbance, although to this cause there sometimes is added a hydremic condition of the blood. Congestion of the pulmonary circulation results chiefly from a disproportionate weakness of the left side of the heart. The blood being forced back into the pulmonary veins, there is necessarily an obstruction to the onward flow in the pulmonary arteries, which causes hypertrophy and final dilatation of the right ventricle. The condition known as passive congestion of the lungs is essentially the result of mechanical obstruction to the pulmonary circulation arising from cardiac weakness with or without mitral lesion.

The symptoms of this condition are usually indefinite in character, although cyanosis and increasing dyspnea are often manifest. Painstaking examination of the chest may disclose at the bases a diminished intensity of the respiratory sounds, with slight changes in pitch and quality. A moderate amount of moisture in the finer bronchioles may be detected in this region. If the congestion is extreme, particularly when associated with fever and certain inflammatory conditions complicating tuberculosis, changes take place in the dependent portions of the lung, to which the term "hypostatic congestion" is applied. This is especially likely to result when the patients are bedridden and essential changes are recognized upon examination. These consist of impaired resonance upon percussion over the affected areas, diminution or absence of respiratory sounds, which, if recognized, are almost tubular in quality, with elevation of pitch and change of rhythm, and attended also by an abundance of bubbling râles. In such cases the cyanosis and dyspnea are very apparent. The cough is loose and productive, the expectoration being frothy, with occasional slight tinges of blood. This condition may be associated with small areas of consolidated pulmonary tissue. The hypostatic congestion is usually bilateral, unless the patient is accustomed to lie for long periods upon one side.

Edema of the lungs, consisting of transudation of the watery constituents of the blood into the bronchial tubes, may result from the combined effect of several causes. It may appear at times of great

debility, with pronounced anemia, or perhaps in association with advanced kidney lesions, or it may result from an acute bronchopneumonia. It may be observed at times as the direct effect of a sudden loss of heart power from any cause. In several instances I have noted this distressing condition as a delayed result of pulmonary hemorrhage, though in such cases a more direct cause should be ascribed to the developing bronchopneumonia consequent upon the aspiration of blood. I have seen its development following carefully graduated subcutaneous injections of salt solution, which were imperatively demanded to overcome an alarming collapse attending the enormous loss of blood incident to pulmonary hemorrhage. Such a clinical phenomenon would appear to be rather in line with the observations of those who report increasing general edema following the administration of salt solution in nephritis.

The symptoms consist of intense dyspnea, cyanosis, and cough. The expectoration is usually copious, distinctly frothy, and tinged with bright blood. There is dulness upon percussion, and frequently absence of breath-sounds, with innumerable bubbling râles, chiefly at the bases. Loud, coarse bubbling sounds referred to the trachea, commonly called the death-rattle, may attend the respiratory effort.

As a remote effect of cardiac weakness there is seen general edema of the ankles, feet, hands, and even of the face. The swelling of the face, as well as of the extremities, is not, as a rule, perfectly symmetric. One foot or ankle is usually swollen considerably more than the other. This is often true of the hands as well. The swelling of the face may be recognized upon one side before the other shows any evidence of edema. Cyanosis of the face is, of course, present to a like degree upon both sides, as well as in the finger-nails. A unilateral flushing of one cheek, however, due to vasomotor change, without other evidence of cardiac disturbance, is frequently witnessed.

CHAPTER XXII

PULMONARY HEMORRHAGE

Allusion has been made to the frequent hemorrhagic onset of pulmonary tuberculosis. It has been made clear that hemoptysis may take place at any time in the course of the disease, apparently without regard to the extent or nature of the morbid pulmonary change. Its development is entirely independent of subjective symptoms or physical signs. It may occur in the absence of fever, cough, emaciation, pulmonary excavation, and recognized cardiac or circulatory disturbance. Even in the midst of seeming health and vigor alarming hemorrhages are not uncommonly experienced, a copious loss of blood suggesting the probability of a ruptured pulmonary aneurysm. Upon the other hand, many consumptives are permitted to linger for years without hemorrhagic experience, although the lungs are known to have undergone very extensive destructive change.

Various observers have reported the proportion of pulmonary invalids suffering from hemorrhage to be from 20 to 80 per cent. In considering

such diverse statements, due allowance should be made for the widely differing conditions under which the respective groups of patients were observed.

It is easy to understand why hemorrhages should be decidedly more frequent among invalids who are not subject to disciplinary control than among those confined within closed sanatoria. The striking disparity recorded as to the frequency of hemorrhages within and without sanatoria has been asserted to be incident purely to the supervisory régime practised in such institutions. It is probable, however, that the incipient character of these cases is accountable in part for the disproportionate observation. In addition, the admirable discipline enforced in sanatoria is of undoubted benefit in greatly minimizing the tendency to hemoptysis. According to the rigidity of supervision, either within or without institutions, hemorrhages are invariably less frequent. In the experience of those who have been privileged to observe a large number of cases outside of sanatoria it has been found that hemorrhagic patients always exhibit a remarkable improvement in this respect upon the inauguration of supervisory control. My own experience, which was reported in 1901, embodied the analysis of 457 hemorrhagic cases occurring at some time in the course of the disease, out of a total number of 900 patients, 20 per cent. of whom exhibited a distinctly hemorrhagic onset of their pulmonary affection. Three hundred and eighty-six cases, or over 82 per cent., occurred before the patients came under my observation. Of these, only 97, or one in four, suffered subsequent recurrences.

Sometimes there is observed a rather striking periodicity in the development of hemorrhages. Long periods with but comparatively few and insignificant hemoptyses have been followed repeatedly by a disquieting frequency of these manifestations among my patients, suggesting more than a mere coincidence. No bacteriologic studies thus far have sufficiently explained such periodic evolution of symptoms, although pneumococci have been demonstrated by Ravenel to be present in some hemorrhagic cases. I have noted the more frequent occurrence of these hemorrhages in Colorado during the spring months, coincident with abrupt changes in the weather. For many years I have been led to regard their greater frequency at this season, corresponding with periods of variability in temperature, increased wind movement, and agitation of dust, as explainable in part by a relation of cause and effect. At such times I have been forced earnestly to admonish patients against undue exposure to wind and dust.

The form or extent of pulmonary hemorrhage varies from a slight spitting of blood to an immediately fatal termination resulting from the perforation of a pulmonary aneurysm.

As a rule, but little importance is attached by physicians to slight bloody discolorations of the sputum. A great difference is observed, however, among consumptives in the mental effect produced even by apparently insignificant hemorrhagic manifestations. The presence of but little blood in the expectoration is sufficient with some not only to induce an unfortunate mental disquietude, but even to arouse the wildest fears, sometimes to the point of utter demoralization. Others who have become more or less accustomed to occasional hemoptyses apparently attach but trifling importance to the expulsion of several mouthfuls of blood. Many patients, priding themselves upon their

past experiences, are inclined to view succeeding hemorrhages with manifest indifference and to disregard precautionary admonitions calculated to prevent their recurrence and minimize their severity. Either of these extreme attitudes on the part of the invalid is especially unfortunate, in view of the difficulty experienced in inculcating a correct and rational conception as to the true significance even of slight hemoptysis. In all cases where there is any considerable admixture of blood in the expectoration it has been my habit, regardless of the history of previous hemorrhages, to acquaint the patient in a reassuring but conservative manner with the possibility of approaching hemoptysis. I have learned to regard these bloody discolorations of the sputum in many instances as precursory manifestations of a severe hemorrhage, which may often be avoided upon the adoption of precautionary measures. It has been my custom to inform patients affecting a disdain for these occurrences that the early slight hemoptysis is analogous to the warning signal displayed in front of an approaching train, which may be ignored only through risk of imminent peril. The impending danger relates not to the slight hemoptysis itself, but, like the precautionary signal, to its *significance*. Many threatening hemorrhages have been avoided by an immediate insistence upon rest, diet, and other details of management.

Moderate hemorrhages may occur at any time, either following exercise, mental excitement, violent cough, a hearty meal, absolute quiet, or during sleep. By moderate hemorrhages are meant the expectoration of from four to eight ounces of bright arterial blood. While some hemorrhages of this character may result from prolonged and violent coughing, others are entirely unassociated with cough only in so far as the hemorrhage itself serves to furnish an exciting cause. Injudicious exercise and excitement must be regarded as potent factors in the production of hemoptysis, on account of the increased arterial tension often induced. Many patients present a history of hemorrhage from prolonged and rapid walking, lifting, running to catch a car, riding a bicycle, driving an automobile or a fast horse, or other forms of physical exercise and recreation. Others suffer a similar experience as a result of undue nervous excitement incident to attendance at the matinée or ball-game, card-playing, heated argument, grief, or excessive worry. Hemoptysis is induced not uncommonly by inhalation of the overheated and vitiated air of public buildings and conveyances. I have had occasion to note this occurrence in several instances at public gatherings, upon street-cars, steam conveyances, and in poorly ventilated apartments. Despite the enforcement of a disciplinary régime, numerous hemorrhages have taken place among my patients while sitting quietly in a reclining chair or resting in a recumbent position upon a couch. Not infrequently they have occurred in the absence of all mental or nervous disturbance, and even *during profound sleep*. I recall several instances of fatal pulmonary hemorrhage developing in the midst of deep slumber. While a history of disturbing dreams is sometimes elicited, the patient in many cases is overcome by an inundating sanguineous flood during unconscious repose. Distinct premonitory symptoms of pulmonary hemorrhage are entirely absent, as a rule. There may be a brief initial feeling of oppression in the chest, followed by a sensation of warmth under the sternum, a saltish taste in the mouth, and expectoration of bright blood, which rises

rapidly in the throat and is expelled in mouthfuls. The cough is more or less choking, rattling, excitable, and sometimes even explosive in character. The bleeding may persist for several minutes, and disappear altogether, or, after an interval of quiet, it may be followed by one or several recurrences. From my experience in moderately high altitudes I have been led to expect, after the lapse of a few hours, at least one or two repetitions of the initial hemorrhage before the bleeding may be regarded as under satisfactory control. The expectoration of clots or blood-stained sputum usually persists for several days after the arterial hemorrhage has ceased. The clots, which are dark in color, heavy, and airless, gradually diminish in quantity and become lighter in color until the expectoration is free from blood.

After moderate or severe hemorrhages the sputum does not always assume its previous gross characteristics, certain changes in the quantity and appearance being discerned. The expectoration may be diminished or increased, and its nature either more distinctly purulent or more frothy than prior to the hemoptysis. A notable reduction of cough and expectoration is not uncommon after the lapse of several weeks. The abatement of former paroxysmal cough is often conspicuous. A previous frothy expectoration sometimes disappears almost entirely after a brisk hemorrhage, presumably on account of the depletion of congested pulmonary areas. Upon the other hand, purulent secretions in the respiratory tract, as a rule, are increased for protracted periods. Upon the advent of bronchopneumonia from the aspiration of blood into the finer bronchioles the expectoration ceases altogether. Upon the development, however, of pulmonary edema, the expectoration becomes copious in amount and frothy in character, with noticeable bloody discoloration.

The most *severe form* results from the perforation of a pulmonary aneurysm or the rupture of a fair-sized artery traversing a pulmonary cavity. These hemorrhages are often immediately fatal, the patient being literally drowned in his own blood. They occur without the slightest warning, and after a few moments of inexpressible anguish all may be over. If the bronchial tubes are not completely inundated by the uncontrollable torrent of blood, there still remains the imminent danger of death from complete exsanguination and collapse. In institutions accepting patients in all stages of consumption it is not uncommon that the unfortunate victim of this type of hemorrhage is found in the morning to have experienced the terrible onslaught during sleep, and to have expired without warning and without assistance. It is astonishing, however, to note what enormous quantities of blood may be lost during a single hemorrhage without causing death. In many instances I have witnessed the loss of over a quart of blood at such a time, which was followed at short intervals by recurrences of almost incredible amount. In such cases the blood is seen literally to gush from the mouth and nostrils, the choking being extreme, and the spectacle, to say the least, terrifying and revolting. The cough is essentially explosive at such a time, large quantities of blood being precipitated in all directions. Several times I have seen the blood expelled with violence over the foot of the bed, bespattering the wall of the room and saturating the clothing of the nurse and attendants. During such a hemorrhage it is inevitable that a considerable portion of the blood finds its way into the stomach, and vomiting further intensifies the distressing experience. Provided the invalid does not

succumb immediately to asphyxiation or shock, sufficient clotting may ensue to produce a temporary cessation of the hemorrhagic flood. In this event the patient is more or less in collapse, greatly exsanguinated, the countenance pallid, respiration sighing, pulse exceedingly weak and rapid,—if, in fact, this is at all palpable,—skin clammy, extremities cold, and the face and brow covered with copious perspiration. In such cases it has been my lot to observe several times a complete disappearance of the pulse for several hours, complete unconsciousness, and violent delirium, followed by recovery from the hemorrhage and ultimate arrest of the underlying tuberculous process. Several individuals enjoying an active and useful existence have in years past undergone experiences similar to the above, but in the vast majority of instances hemorrhages of this character are attended by a speedy fatal termination. Profound nervous and mental disturbances accompanying pulmonary hemorrhage are not, as a rule, frequent, although occasionally observed. Delirium is marked only after excessive bleeding, and then rarely. I recall but few instances of this kind. A patient has recently experienced one of these almost indescribable hemorrhages during sleep. The delirium was immediately violent and maniacal, the invalid for five or six hours shouting at the top of his voice, and the screams being interrupted by repeated hemorrhages. The initial loss of blood was considerably in excess of one quart. The pulse could not be felt for an hour, and I certainly expected every moment to be his last. After excessive stimulation and the administration of a large amount of morphin comparative quiet was restored, and upon the following day the patient could not remember the occurrences of the preceding twenty-four hours, not even to having experienced a pulmonary hemorrhage. Another patient, a lady of forty-two years, after a copious and exceedingly alarming hemorrhage, remained markedly delirious for two weeks. Suicidal mania has been exhibited in several cases as a direct result of the hemorrhage. While hysteria, melancholia, or functional nervous disturbances do not often occur during severe pulmonary hemorrhage, their subsequent development is not infrequent.

Pulmonary hemorrhages should be considered further with reference to their *immediate* and *remote* effects.

The **immediate effects** consist of the essential danger to life attending the occurrence of this unfortunate complication. The first danger is that of asphyxiation from inundation of the bronchial tubes. This is followed by the possibility of sudden collapse from the shock incident to the more or less complete exsanguination. Upon survival of these early dangers there exists the problem of general exhaustion. In my own experience, by far the most imminent peril attaching to the occurrence of pulmonary hemorrhage is the alarming frequency with which bronchopneumonia develops. This much-to-be-feared complication, which, following a hemorrhage, is almost universally fatal, may supervene entirely irrespective of the size of the hemorrhage or the previous condition of the patient. No one can foretell that the aspiration form of pneumonia will not terminate life after hemorrhages which are apparently benign in type. Several times have I observed its dread onset following the expectoration of but a few ounces of blood in patients with little tuberculous infection. Others, despite a greatly reduced physical condition, have survived numerous

hemorrhages without its development. This complication may appear insidiously, or its onset may be displayed with abrupt symptoms. I have never seen it develop later than the fourth day. The fever may rise suddenly on the second day, and remain elevated in the neighborhood of 103° or 104° F., or the temperature may begin a gradual ascent upon the third or fourth day. After two or three days of rising temperature following the hemorrhage, the respirations become correspondingly rapid and the pulse greatly accelerated, weak, and easily compressible. The face at first is suffused, and later becomes cyanotic. The countenance in the beginning is animated, the expression anxious, with the temperament somewhat excitable. The tongue is furred, and the breath heavy and foul, despite free catharsis. With increasing cyanosis involving the nails and face, the mental condition often changes from a state of excitability to hebetude, although not invariably. From a large experience with such cases I can assert that I have never witnessed a recurrence of hemorrhage after the symptoms of pneumonia have once become defined. Neither have I found the cough to be a factor of any importance at this time. This, together with the expectoration, usually disappears entirely with the rise of temperature and continued acceleration of pulse and respiration. No pronounced morning remissions of temperature are exhibited, as a rule, and no sweats. The respirations rapidly become more labored, the alæ of the nose dilating with each respiratory act. At this time the Cheyne-Stokes type of respiration may be observed. The pulse often rises to 160 or over, and is of exceedingly poor quality, in spite of every effort toward stimulation. Stupor, with or without delirium, makes its appearance. The patient, in the vast majority of cases, speedily succumbs, the duration of the condition seldom lasting over four or five days after the onset of pneumonia.

It is quite unnecessary to demonstrate the physical signs of pulmonary consolidation in order to confirm the suspicion of bronchopneumonia. A satisfactory examination of the patient is often impracticable, on account of the difficulty of access to the back. The subjective symptoms above described, occurring a few days following hemorrhage, are amply sufficient to justify the gravest fears and the rendering of an unfavorable prognosis.

The **remote effects** of pulmonary hemorrhage are varied to a considerable extent, its influence upon ultimate prognosis, therefore, being somewhat uncertain. While unquestionably good results may occasionally follow severe hemorrhages, such happy effects are, upon the whole, infrequent.

It has been stated by some that hemorrhagic cases, as a whole, may be expected to do better than the non-hemorrhagic. If true, this is explained in part by the fact that the onset of a brisk hemorrhage early in the disease may lead to a realization of the necessity of rational management. I have been unable personally to ascribe to hemorrhage cases as a class any distinctly favorable or unfavorable influence upon the ultimate prognosis. Of my cases taken as a whole, irrespective of the question of hemorrhage, 68.5 per cent. have been reported as showing improvement. By this is meant a material lessening of the activity of the tuberculous process, as disclosed by the physical signs, a diminution of cough and expectoration, a reduction of pulse and temperature, with increased appetite, digestion,

and weight. On account of the heterogeneous nature of the cases, most of them far advanced in type, it is perhaps better, for the purposes of comparison, in this connection not to confine the analysis merely to the completely arrested cases. Of the hemorrhagic cases, which constitute a little over 50 per cent. of the total number, 67.8 per cent. have been reported as improved. This comparison in itself fails to indicate any special influence of the hemorrhage upon the course of the disease. It is noteworthy that one-fifth of these hemorrhages occurred as the initial symptom of tuberculosis, and impelled the patient, apparently in good health, to adapt himself without delay to a method of living appropriate for pulmonary invalids, thus establishing a relatively high percentage of improvement for this particular class of hemorrhagic cases. On the other hand, numerous specific instances illustrate clearly the remote deleterious effects of hemorrhage occurring later in the course of the disease. It should be remembered that hemorrhage *per se* is but one of many manifestations peculiar to a disease which exhibits widely differing pathologic conditions. This single symptom, associated with all manner of complicating conditions, is possessed, in different individuals, of varying degrees of clinical importance. In exceptional cases the hemorrhage has been found to exert an influence for good, as shown by diminished cough and expectoration, lessened temperature, improved appetite, and increase in weight. It is sometimes possible to date the beginning of definite improvement from the onset of pulmonary hemorrhage, but in general its prognostic significance in advanced phthisis is distinctly unfavorable. There inevitably results a decided loss of weight from the diminished alimentation, and a pronounced diminution of resistance from the more or less prolonged confinement. Digestion is usually impaired for a time by the employment of opiates, which are necessitated by the frequent irritating cough. While in many instances a gradual return to previous conditions may reasonably be expected, the intercurrent complication, nevertheless, has constituted an unfortunate interruption to forward progress, involving in all cases loss of *time*, and in some, of *opportunity*.

THE INFLUENCE OF CLIMATE UPON PULMONARY HEMORRHAGE

Allusion has been made to the relation of hemorrhage to such atmospheric conditions as wind and dust. In addition to these factors, which may be regarded as exciting causes, other climatic attributes have been found to exert an influence for and against the production of hemorrhage. Extreme variability of temperature is perhaps a factor of some importance. I have not been able to observe any special difference in the frequency of pulmonary hemorrhage during the winter or summer months, and am unable, therefore, to conclude that the continued inhalation of cold air is at all instrumental in its causation. The sudden changes of temperature, with an increased amount of wind and dust, incident to the springtime in Colorado, have been associated with an increased number of pulmonary hemorrhages, giving rise to a belief in the existence of a causal relation. Perhaps the chief interest as regards the relation of hemorrhage to climate centers in the influence of altitude. In the past, the conviction has been somewhat general that altitude directly increases the frequency of its occurrence. This more or less popular notion is not based upon the substantial facts of

experience. From a physiologic standpoint it would appear that the increased depth and frequency of the respirations, together with the rate and vigor of the heart contractions incident to moderate altitudes, would produce an acceleration of blood-flow and an equalization of the circulation throughout the body. In addition to this tendency toward the avoidance of local stasis in the lungs in appropriate cases, recent experiments have shown conclusively that the blood-pressure is lower in high altitudes than at sea-level. The assumption, therefore, seems well founded that pulmonary hemorrhage in high altitudes should be distinctly *lessened* in cases judiciously *selected* with reference to *other considerations*. My own experience in Colorado is quite in keeping with this view. Only one-fourth of the cases to which allusion has previously been made have experienced a recurrence of their pulmonary hemorrhages subsequent to arrival in Colorado. Quoting from my analysis of hemorrhages in Colorado: "It is further of interest to know that of the 97 recurrences, 34 were in individuals who had experienced a hemorrhage within two weeks before arrival, and in whom it is reasonable to suppose the direct results had not been fully overcome. In fact, nearly *half* of these had their hemorrhage on the train or immediately prior to leaving home. Twenty-two of the recurrent hemorrhages in Colorado were exhibited by people in whom the bleeding not only took place shortly before arrival, but the recurrence within a very few days thereafter. It is obvious that such cases should not be embraced in the category of 'hemorrhages in Colorado,' as the specific cause was put in operation before arrival. Should these be excluded, and rightly so, the percentage of recurrences would be materially diminished. On the other hand, 47 cases were found to have bled more or less profusely within one or two weeks before arrival, yet have never suffered a return since residing in the higher altitude. Seventy-one patients experienced their *first* hemorrhage *after* coming to Colorado. Forty of these exhibited very extensive advanced infection, presenting such conditions as would be likely to occasion hemorrhage anywhere. Of the 31 which took place in the midst of a general gain, a large proportion resulted from a distinct assignable cause." My experience during the six years subsequent to the compilation of these statistics parallels closely the analytic results previously obtained.

Hemorrhages *per se* constitute neither an indication nor a contraindication for high altitudes. The choice of climate should be made with reference to all the several phases and conditions, without special attention to hemorrhage itself. A small proportion of recurrences may be expected in moderate altitudes, and this number may be diminished still more by the institution of proper supervisory control. Recurrences are more prone to ensue in those patients who bled from the lungs shortly before arrival, in which event the subsequent hemorrhages are likely to take place during the first few days of residence in higher altitudes. Primary hemorrhages are comparatively rare in moderate altitudes, and, as a rule, occur in cases with active and extensive excavation or as a result of some palpable indiscretion. While hemorrhages are less apt to take place in higher altitudes than at sea-level, they are, however, decidedly more severe and associated with greater shock. Hemorrhages occurring in Colorado do not, as a *rule*, conform to the benign type so often observed at sea-level.

CHAPTER XXIII

SYMPTOMS REFERABLE TO THE DIGESTIVE APPARATUS

Disturbances in the alimentary tract may relate either to the *stomach* or to the *intestine.*

STOMACH SYMPTOMS

Gastric disturbances are by no means common to all cases of pulmonary tuberculosis. A large number of patients are able to take prodigious quantities of food and digest it with apparent ease. An excellent appetite with ability to digest food is sometimes noted to an astonishing degree, even in advanced cases, notwithstanding the presence of fever and extensive pathologic change. On the other hand, there is a large class of patients who exhibit disorders of digestion with confirmed loss of appetite in the very early stages of consumption, or long before the development of the disease. In such cases the gastric symptoms are exceedingly apt to persist throughout the entire course. In another class of patients the stomach disturbances are of temporary duration, though subject to frequent recurrences by virtue of fever, nervous excitement, general exhaustion, and indiscretions of diet. As a matter of fact, it is worthy of comment that the functional power of the digestive organs is not impaired more frequently and seriously by reason of these causes. This is all the more remarkable in view of the lack of exercise, the toxemia, malnutrition, and coëxistence of psychoneuroses. The constancy and severity of the gastric symptoms are entirely independent of the extent of pulmonary lesions. Generally speaking, the indigestion is more apparent and obstinate in the presence of continued elevations of temperature, general weakness, and functional nervous disturbances. In very many cases, particularly of the neurotic type, it is known that an actual structural change in the digestive apparatus is not essential for the production of the various symptoms of functional derangement. It is of further interest to note that severe dyspeptic manifestations often occur in the presence of normal gastric secretions. A predominating effect, then, may be ascribed in many patients to the depraved nutrition, the anemia, the nostalgia, and the enforced quiet. In addition to these influences, the profound psychoneurotic condition so common among pulmonary invalids is an etiologic factor of especial importance. Often this functional derangement is responsible for a picturesque display of clinical manifestations. The symptoms referable to the stomach partake essentially of the nature of sensory neuroses, neurasthenic consumptives being notoriously introspective and hypochondriacal. Various causes may operate in individual cases toward the production of gastric disturbance. The organic changes sometimes relate to a preëxisting chronic catarrh of the stomach, the mucosa being the site of passive congestion incident to coëxisting cardiac or renal complication. Occasionally, the results of dilatation and enteroptosis lend additional color to the dyspeptic picture. Ulceration and tubercle deposit in the stomach are comparatively rare. In the absence of patho-

logic change in the abdominal viscera the disturbed digestion may be attributable in some cases to recognized abnormality of the stomach secretions. A frequent deviation from the normal, as determined by gastric analysis, is the existence of hypochlorhydria in advanced stages. Irrespective of fever, the hydrochloric acid may be reduced in amount or absent altogether at any period of the disease, although, as a rule, in early phthisis this constituent of the gastric secretion is normal in amount. In later stages there is found in many cases a pronounced diminution.

Independent of the precise quantity of hydrochloric acid, hyperacidity of the stomach-contents is frequently due to an excess of the organic acids. The gastric indigestion, especially if developing late in the disease, is sometimes but an expression of the general exhaustion. At such times there is a lack of muscular tone to the stomach, with resulting motor insufficiency.

Acute indigestion following indiscretions of diet is often characterized by nausea, with or without vomiting, anorexia, bad taste in the mouth, furred tongue, offensive breath, headache, constipation, and sometimes pain in the epigastric region. Slight jaundice may be an accompanying symptom.

Patients suffering from chronic catarrh of the stomach experience loss of appetite, occasional loathing for food, coated tongue, occasional vomiting, tenderness upon pressure over the region of the stomach, and a constipated habit, with almost constant diminution of hydrochloric acid.

When the gastric indigestion exists as a concomitant manifestation of general exhaustion or profound neurasthenia, there is often an entire lack of desire for food of any kind, the very idea of eating producing extreme disgust. In some of these cases actual hunger is described, until the process of ingestion is begun. Upon endeavoring to partake of a slight amount of food, such patients complain of the utter impossibility of the task, some describing an imaginary obstruction in the esophagus. A characteristic symptom is the abrupt onset of vomiting shortly after food is consumed, or even before the meal is finished. This is particularly true of the evening repast, and perhaps is explainable in part by the increased temperature elevation at this time. The vomiting occurs without any ostensible cause, and is not to be confounded with the retching and loss of food incident to paroxysmal cough. In the latter case the vomiting is not dependent upon a digestive disturbance, but is referable entirely to the influence of the cough itself. In both instances, however, the vomiting is of purely reflex origin, the presence of food in the stomach, eructation of gas, or cough acting as exciting causes. The popular appellation of "stomach cough," applied to such cases, is, of course, an unfortunate misnomer, although it has been recognized that a hearty meal may serve to excite cough.

Patients suffering from neurasthenia frequently exhibit other symptoms of gastric disturbance of such a character as to justify their classification under the head of "nervous dyspepsia." With such patients the process of digestion is not always retarded to any extent in spite of the presence of symptoms suggestive of serious impairment of stomach function. The most conspicuous symptoms relate to pain in the epigastric region, nausea, pyrosis, and frequent loud eructations of gas. The latter usually take place when the stomach

is empty, and disappear for a short time following the consumption of food. The abdominal distress frequently occurs independently of the ingestion of food. There is often a decided sensation of fulness in the stomach, associated with perceptible distention. The tongue sometimes is red instead of coated, and the breath inoffensive. Anorexia may be extreme, but vomiting is not an invariable feature. Constipation is usually the habit of the individual.

INTESTINAL SYMPTOMS

Disturbances of digestion originating in the intestine constitute an important feature of pulmonary tuberculosis. The condition of the bowels is of the utmost consequence, and not infrequently furnishes a sufficient basis for rendering an unfavorable prognosis. The intestinal derangement of chief importance is *diarrhea*. This may develop early or late in the disease, be temporary in duration, exist for months, or persist throughout the entire course. It may occur without other symptomatic manifestations, and in the presence of comparatively slight pathologic change in the pulmonary tissue, or it may be absent in the midst of extensive tuberculous involvement. Both the character and extent of the diarrhea vary within wide limits. There may be but a few movements of the bowels, and these restricted to the early morning hours, or there may be six or eight watery evacuations during the day. In the former case the desire to empty the bowels immediately upon awakening is imperative, although sleep, as a rule, has not been disturbed. After one or two later operations, which usually take place after breakfast, the patient complains of no further inconvenience during the day. The dejections in such cases are attended with but little, if any, physical discomfort, are almost invariably liquid, but rarely "watery," and seldom contain mucus or blood, although often very offensive.

Patients in whom the intestinal disturbance is more severe are frequently awakened during the night and at a very early hour in the morning. The discharges are uniformly described as watery in character, but in reality are of a thin, soupy consistency, and sometimes contain blood and shreds of mucus. As a rule, the movements become less copious as the day advances. Intestinal flatulence is sometimes an annoying feature. When the diarrheal dejections exceed three or four in number during the twenty-four hours, there is frequently considerable griping colicky pain.

Diarrhea may appear as a most distressing symptom, even in the midst of general improvement, and affords no criterion by which to judge as to the degree of activity of the pulmonary infection. It is a common error to regard a persisting diarrhea as invariably dependent upon a tubercle deposit in the intestine. Further, the demonstration of tubercle bacilli in the discharges does not always afford conclusive evidence that the condition is necessarily hopeless. In a large proportion of the diarrheas of consumptives it is impossible to conclude definitely that the local condition is tuberculous in character. It is easy to theorize upon the possible development of an intestinal infection from the swallowing of sputum laden with tubercle bacilli. This undoubtedly takes place in numerous instances, but clinical experience often fails to disclose either the actual existence or incurability of such lesions.

Considering the wide dissemination of educational literature, it is hard to realize that any but the densely ignorant can be guilty of swallowing their sputum. From my own observation I am led to believe that this is a rare occurrence, possibly taking place among insane patients or those so exhausted by disease as to blunt their sensibilities and obliterate any appreciation of the proprieties and decencies of life. I am convinced that the swallowing of expectoration, save in little children, is far less frequent than commonly believed. Assuming, however, that in some cases bacilli-laden sputum finds its way into the alimentary tract, it must be borne in mind that the microörganisms are surrounded to a certain extent by a protective coating of mucus, and diluted more or less by the stomach and intestinal contents. In a very considerable number of cases the diarrhea must be attributed to some other cause than intestinal tuberculosis.

Continued looseness of the bowels is occasionally observed among invalids who have never experienced any cough or expectoration whatever. Perhaps this very fact is of value in explaining the possibility of an irritation of the nerve terminals, with resulting increased peristalsis, from an absorption of the toxins incident to the pulmonary infection. The production of diarrhea by the injection of large doses of tuberculin is suggestive of the correctness of such conclusions. It is possible that the swallowing of sputum, save in young children, is less responsible for the diarrhea of consumption than has been asserted. A pronounced and continuous looseness of the bowels furnishes *per se* no positive evidence of tuberculous lesions within the gut, although suspicion is at once aroused as to the possible nature of the affection. This is strengthened by the presence of blood and mucus, even in small amounts, in the rectal discharges, but the recognition of tubercle bacilli constitutes the only means by which definitely accurate conclusions may be attained.

A diagnosis of intestinal tuberculosis does not necessarily imply a hopeless prognosis, despite a poor general condition and an active involvement of the lung. During the past few years I have been privileged to witness surprising improvement in several patients of this class who were regarded as hopeless by virtue of every consideration which would ordinarily influence prognosis. I am attending a lady who, two years ago, exhibited distressing symptoms of intestinal tuberculosis, with accompanying exhaustion, fever, and the physical signs of advancing cavity formation. The pulmonary infection had been of several years' duration, and the intestinal disturbance had persisted during a period of over six months. There were from six to ten movements of the bowels daily, containing small quantities of blood and mucus. With improvement in the general condition, disappearance of fever, and lessened activity of the pulmonary process there gradually took place an amelioration of the diarrhea, and for the past eight months the bowel discharges have been entirely normal.

A young man of twenty-five, a medical student, with moderate pulmonary involvement, developed quite suddenly a diarrhea which persisted for several weeks. This was associated with rapid loss of flesh and strength and moderate elevation of temperature. There was no blood or mucus in the discharges, but bacilli were readily found upon examination. The patient was put to bed and a rigid diet, with appropriate medication, instituted. After some weeks he was per-

mitted to remain upon the porch a portion of each day. This method of management was maintained for over a year, until the movements became perfectly normal in number and appearance and repeated examinations disclosed no bacilli. In the mean time there has taken place an entire arrest of the pulmonary infection.

I have in mind three other cases now under observation which also illustrate the possibility of improvement in cases of this character. As a rule, however, intestinal tuberculosis occurring in advanced stages of consumption must be regarded as a most ominous complication. The tuberculous lesions may affect any part of the intestinal tract, but the region of the cecum is more frequently involved. There is often definite ulceration, the ulcers being irregular, round or ovoid in contour. Extensive hyperplastic change sometimes takes place. Intestinal tuberculosis will be discussed more fully under Complications.

CHAPTER XXIV

SYMPTOMS REFERABLE TO THE MIND AND NERVOUS SYSTEM

Considerable interest attaches to the mental condition of the pulmonary invalid. Deviations from a normal mental status are ascribed to many consumptives, who are often spoken of as irritable, unreasonable, selfish, or cranky. An effort has been made to group the mental attributes of tuberculous individuals in such a manner as to permit their classification according to distinct types. Many so-called characteristics of the consumptive have been supposed to develop as a direct result of the pulmonary affection. Some of these peculiarities of temperament are thought to obtain particularly during the early period of pulmonary tuberculosis, and to be replaced later by widely differing manifestations.

Such notions, entertained with reference to essential traits of character common to this class of invalids, are largely incorrect. Fundamentally distorted views have been accepted as to the relation existing between the underlying disease and the various forms of mental or nervous disturbance. The central thought to be borne in mind in this connection is the fact that it is not the pulmonary infection which serves to modify character, but rather the inherent peculiarities of temperament which tend to influence materially the clinical course and prognosis of consumption. Generally speaking, those individuals who are depressed, melancholic, and pessimistic before the onset of tuberculosis will exhibit the same distinctive tendencies subsequent to its development. Those who are sanguine, optimistic, and of an expansive turn of mind will remain unchanged. The densely ignorant and obstinate cannot be transformed through the advent of a condition entailing suffering and disappointment. Those who are irritable, wilful, and unrestrained cannot fail to stamp the impress of their unfortunate nervous infirmities upon the clinical picture. The vital point is the

thought that it is not the disease itself, but rather the individual, offering the greater field for study and attention.

The practical consideration relates to the extent to which the previous mental status is actually altered either directly or indirectly as a result of pulmonary tuberculosis. It is entirely natural to expect some temperamental change by reason of the physical restraint and mental disquietude incident to the invalidism and the environment. It is contended, however, that such changes are not sufficiently constant or uniform in their nature to justify a general classification. It is futile to attempt any *definite generalization* with reference to the mental attitude of the consumptive, and the larger one's experience, the less likelihood of indulging in such an effort. In advanced cases individual modifications of disposition may easily take place as a result of the general weakness, precisely as in other exhausting diseases. With many patients exhibiting evidences of profound toxemia the mental or nervous equilibrium is rendered still more unstable. Less advanced consumptives are inevitably influenced to some extent by their markedly altered conditions, their immediate surroundings, and prospects for the future. The knowledge of their physical state, the separation from home, the life of indolence, the absence of high ideals, the lack of healthful occupation of the mind, the association with others similarly afflicted, and in some instances the interminable duration of the illness, must modify to some extent their natural characteristics. By virtue of these causes some invalids may exhibit a certain accentuation of their inherent peculiarities; others may display a slight perversion of former proclivities, and a few may disclose acquired degenerative tendencies. It has been stated comparatively recently by various writers that consumptives, through the very nature of their disease, become more or less perverted nervously, cultivating habits of self-indulgence, loss of self-control or moral restraint, developing an inability to appreciate the proportionate fitness of things and exhibiting the stigmata of varying degrees of degeneration. While such broad generalizations are quite unwarranted, the fact remains that consumptives, like other individuals, are necessarily creatures of their environment. From my own observation, the most frequent resultant of the various component factors is the development of a remarkable adaptation of the individual to new surroundings and a philosophic acceptance of the radically changed status in life. An admirable resignation is more often exhibited than a rebellious disposition. Unwillingness to conform to the implacable necessities of physical disability is, indeed, unusual. Following the shock of the initial information as to the character of the disease, the attitude of the average consumptive, despite an intelligent conception of the grave possibilities, is that of unflinching courage. Notwithstanding the doubtfulness of the issue, the immediate future is often contemplated with philosophic acceptance. In most instances there is exhibited a lingering and abiding hope, rather than actual faith, in a favorable outcome. This intention to meet with fortitude what may be held in store should not be described as a form of optimism or of pessimism. Either of these may be present in individual cases, but such does not typify the mental condition of pulmonary invalids as a class.

The optimism, which so often has been stated to characterize the attitude of the consumptive even in the last hours, is usually founded upon ignorance of the impending danger. This results either through

misrepresentation by the physician and family, or on account of an utter inability of the patient to comprehend statements that have been made.

Pessimism, when present, is not, as a rule, the result of long-continued and unavailing efforts toward securing arrest in the sense that "hope deferred maketh the heart sick," but rather is an outward expression of the mental makeup of the individual. After years of fruitless endeavor to promote recovery the attitude of the patient usually becomes that of stoical indifference rather than of pessimism, depression of spirits, or melancholia. These latter attributes were of earlier formation, and usually entered into the character of the patient previous to the disease. Temporary periods of depression from minor causes are fairly common, perhaps characterizing a larger number of pulmonary invalids than the exaltation of spirits which is sometimes attributed to them. Moderately increased irritability of temperament is not infrequent, and is accompanied by a tendency to worry over trifles. Often these are magnified to such an extent as to assume undue proportions in comparison with vital considerations to which little importance is attached. The inability to appreciate fully a due sense of proportion which is occasionally displayed in individual instances may be described as a lack of critical faculty obtaining among consumptives in general. Some become less cheerful, are especially susceptible to annoyance, and quick to take offense. There are often exhibited impulsiveness, emotional weakness, and astonishing fickleness of mood. The changes from despair to exuberance of feeling and vice versâ are striking and kaleidoscopic. The absence of self-control is one of the more important features, together with a certain dependence upon others and lack of aggressive initiative. Reduction of will power and inability to think strongly and consecutively are sometimes observed. A few, as a result of their long-continued habits of idleness, with perhaps previous non-existence of high incentives, become utterly devoid of ambition and degenerate into a state of gossipy incompetence. From my personal observation, however, I can assert with emphasis that a large number of pulmonary invalids, as a direct result of their own suffering, both mental and physical, and intimate contact with misfortune and misery in others, are led to a life of greater sympathy and broader charity.

PERVERTED MENTALITY

In addition to the frequent exaggeration of previous temperamental tendencies among pulmonary invalids, the functional nervous disturbances may be of such a character as to constitute a distinctly perverted cerebration. These morbid psychologic states are usually not sufficient in degree to justify their classification under the heading of insanity. The evidences of a disturbed mental equilibrium may consist merely of a definite suspicion of men and things. Usually this is associated with a gloomy disposition, surly manner, and a pronounced skeptical or pessimistic attitude. Such patients are quick to take offense over imaginary grievances, readily become perversely argumentative, are apt to attach an erroneous significance to the tenor of one's remarks, misconstrue motives, develop implacable animosities, and cherish vindictive tendencies.

Fixed delusions are rarely observed in the course of consumption.

Monomania, when present, is almost always an expression of a previous disturbed mental condition, and is largely independent of the pulmonary disease. It may be intensified to a degree by the exhaustion, inanition, toxemia, and psychic conditions incident to the tuberculous infection. The paranoia may have been previously latent in some cases, and subsequently become a prominent and discomforting feature, through the immediate influence of severe intercurring complications. I have seen delusions make their appearance shortly after the onset of a severe pulmonary hemorrhage and pneumothorax. In fact, in a few exceptional cases a complete transformation of the disposition and character of the patient has followed these two unfortunate occurrences.

The delusions which are observed in connection with hemorrhage and pneumothorax do not always become apparent until after the acutely grave symptoms incident to the complication have subsided. The delayed delusions which I have observed under such circumstances have been almost invariably of an unpleasant character. They usually have been associated with the sudden adoption of a sullen, irritable, and morose disposition, with a distinct tendency to gloomy forebodings.

Hallucinations may be present during short periods as a result of meningeal tuberculosis, extreme general debility, or marked hysteria. They also may occur after an abrupt elevation of temperature from any cause, in the midst of intense physical suffering incident to pneumothorax or severe pulmonary hemorrhage, during the course of bronchopneumonia, and particularly in patients who have been addicted to undue alcoholic stimulation. Delusions, hallucinations, and even complete temporary insanity occasionally attend functional disturbances accompanied by intense pain in females. There is a lady now under my care who is subject to such disturbances at intervals. She recently exhibited, during a period of twelve hours, coincident with a severe migraine, dilatation of one pupil, inability to protrude the tongue, difficulty in articulation, paralysis of one side of the face, one arm, and one leg, and entire absence of normal cerebration.

Delusions and recurring hallucinations developing suddenly during the course of pulmonary tuberculosis and not occurring as terminal symptoms are often but temporary in duration. A proper environment, with painstaking detailed management, increased nutrition, and, above all, the judicious employment of opium, are usually sufficient to restore the patient to a normal mental condition.

The reëstablishment of the former mental state may be expected to correspond to a degree with the manifestations of general improvement. In the midst of a continued general decline initiatory mild delusions are sometimes replaced by an active delirium which persists for months. I have seen distinct maniacal symptoms with raving delirium continue for two months in a patient who had suffered an intercurring pneumothorax.

Insanity with suicidal mania is not uncommon as a final result of the profound depression and melancholia occasionally witnessed in pulmonary invalids. I have observed three cases of suicide among my patients in whom the melancholia had been of comparatively short duration, even developing in the midst of general improvement. Somewhat analogous is the case of a lady, thirty-five years of age, who developed complete functional insanity notwithstanding an increased nutrition and an entire arrest of the tuberculous process. Her condition

upon arrival in Colorado was that of an active extensive tuberculous infection of each lung. There was severe cough, with copious expectoration, great emaciation, anorexia, daily fever, pallor, and dyspnea. After remaining in bed for many months in the open air and displaying remarkable improvement in all respects, there became manifest a loss of memory, great difficulty of speech, inability to articulate, lack of comprehension, and failure to recognize her own family. There were well-defined delusions of fear, the patient several times attempting to jump from a second-story porch. Hallucinations were frequent. Although there had taken place a remarkable gain in weight, the nutrition later was maintained with much difficulty, as she exhibited a positive unwillingness to take food. She endeavored many times to swallow the contents of the sputum-cup, and indulged in other practices equally revolting. The condition was at first regarded by the consultant, Dr. Pershing, and myself as a functional psychosis incident to the general exhaustion, but it was somewhat difficult to reconcile this view with the fact that the mental disturbance developed during a pronounced general improvement. After the insanity had persisted for fully three months she was sent home to a lower altitude as hopelessly insane. Within two weeks following her return her mind apparently was completely restored. After the lapse of three years there has been no return of her mental disturbance and no evidence of renewed activity of the pulmonary disease. The case is reported simply because of its anomalous characteristics.

Evidences of a disturbed mentality are observed quite frequently toward the end of the disease. There may be delusions, mild or raving delirium, stupor, and coma, in some cases independent of the existence of a terminal tuberculous meningitis. This disease presents well-defined manifestations, and will be considered at some length under the subject of Complications. Disturbances of the peripheral nervous system, consisting of hyperesthesia, paresthesia, anesthesia, neuralgia, and other phenomena common to the various forms of neuritis, though sometimes observed in consumptives, are scarcely worthy of special consideration.

INSOMNIA

Although many consumptives suffer from disturbed sleep, insomnia is not a constant feature of the disease, bears no fixed relation to the physical condition or other subjective manifestations, and is due only in part to the coëxistent pulmonary condition. The loss of sleep can be traced in many instances to preëxisting nervous disturbances or idiosyncrasies of temperament. The insomnia may precede consumption for many months or years, and disappear entirely after the advent of the tuberculous infection by virtue of a perfected system of management, and the psychic influence attending change of surroundings. Inability to sleep, therefore, is not immediately referable to the disease which it accompanies, save in those cases in which an associated etiologic factor can be assigned.

Many consumptives, irrespective of their physical condition, experience but little difficulty in sleeping. Rest may be disturbed slightly by cough, which in some instances occurs immediately upon assuming the recumbent posture, and then subsides for the night. Others suffer no especial exacerbation of cough upon retiring, but their

subsequent sleep is frequently disturbed. Night-sweats may be a factor in the production of insomnia, the patient reposing quietly until awakened in the midst of a drenching perspiration. The discomfort incident to this distressing symptom is usually such as to preclude an immediate resumption of sleep. In many cases the origin of the insomnia is traceable to nervous excitation incident to external causes. Animated conversation late in the evening, a controversial argument, exuberance of spirits through injudicious social indulgence, card-playing, and enlivening music often act as exciting causes. Among some pulmonary invalids the sleeplessness, although exhibiting variations in degree, may be more or less continuous and constitute a clinical manifestation of considerable importance. With other patients it is of purely temporary duration. Comparatively few consumptives suffer from insomnia as a result of worry over their unfortunate condition. There may be sources of fleeting anxiety and disquietude, but these disturbances in many instances are occasioned by trifling affairs, as fancied grievances and personal slights, which are often exaggerated until they assume prodigious proportions. These mental obliquities are far more apt to cause nervous excitation and induce loss of sleep than is actual fear regarding the future. The attitude of many patients when unruffled by disturbing trifles is apparently that of complacent acquiescence.

Among patients suffering from confirmed insomnia regardless of exciting causes there are some who find it hard to fall asleep, but finally secure their rest after the lapse of several wakeful hours. Others experience no difficulty in going to sleep shortly after retiring, but invariably awaken a few hours later, to toss and turn during the remainder of the night. It is quite characteristic of a large class of patients who are troubled with insomnia to awaken unreasonably early in the morning. Many invalids possess the happy faculty of sleeping during the day as well as by night. Some of these will average from two to three hours daily without apparently detracting from their ability to enjoy peaceful repose at night. The favorable prognostic import of this gift is almost inestimable. With some patients its attainment appears an absolute impossibility.

Sleep is not infrequently broken by disturbing dreams. These are more likely to be unpleasant than otherwise. In the more advanced cases of pulmonary phthisis the sleep may become a heavy stupor, the patient remaining for hours in a state of semicoma. Taken as a whole, the insomnia of consumptives depends largely upon the temperament and nervous state of the invalid, and though influenced to some extent by associated disturbances, is not inherent to the tuberculous infection. In fact, when present, it is more a result of the environment than of the physical condition, and responds to management directed to the individual rather than to the disease. The ability to sleep is sometimes affected strikingly by the influence of climate. It should be borne in mind, however, that the result is not always to be attributed to the climate itself, but often to the psychic influence and change in environment. It has been my observation that prolonged and refreshing sleep is more easy of attainment in high altitudes than at sea-level. Many patients, shortly after arrival, express surprise and gratification at an ability to sleep to an extent previously unknown. The reverse is sometimes true, though less frequently. In some of the latter cases suggestion plays an impor-

tant part, as the invalids are often told before leaving home that they may experience difficulty in sleeping at high altitudes. In 1898, in a paper entitled "Functional Nervous Disturbances in Pulmonary Invalids," I called attention to the very frequent association of consumption with the various forms of functional nervous disturbances, and from an analysis of 350 cases endeavored to study the relation existing between the two. It was found that in almost no case were the manifestations of nervous disorder displayed for the first time in Colorado. But few suffered an aggravation of the nervous symptoms after arrival, and many of these exhibited a satisfactory improvement. Some patients displayed a persisting insomnia, and in these cases the gain was slow and interrupted by periods of vexatious exacerbations. The continued loss of sleep was found to be of decidedly unfavorable influence upon prognosis, not merely from the entailed exhaustion, but, also, as an expression of the more profound nervous irritability with general susceptibility to all depressing or exciting influences. The few who displayed increased nervous excitation did so coincidently with a corresponding loss in the general condition. Some presented evidences of nervous disturbance attributable directly to external causes, which would be operative in any climate, as excessive dissipation, extreme burden of business cares, and unfortunate domestic relations. A reasonable interpretation of my analytic study at that time, which has been confirmed by subsequent observation, suggests that the influence of the climate upon the nervous condition is especially advantageous in a large proportion of cases by virtue of the increased nutrition and resulting general improvement. It can be assumed that the tuberculous invasion may render more pronounced all preëxisting nervous disturbances, may increase individual susceptibility to such conditions in those already predisposed, and may provide a greater likelihood for their acquired development through the influence of impaired nutrition and general exhaustion. Likewise the existence of well-marked functional derangement affords additional opportunities for the extension of the tuberculous infection through the lessened resistance of the individual. Impaired general nutrition, while often a *result*, is also a most important factor in the *causation*, of *each* diseased condition. It is thus evident that the nervous disturbance may be expected to diminish almost invariably in proportion to the degree of arrest of the tuberculous process and the gain in the general strength.

It has often been asserted that the existence of insomnia and other nervous manifestations contraindicates recourse to moderate or high altitudes for the consumptive. This position is entirely in opposition to the logic of actual experience in such localities. Such statements predicate the assumption that improvement in the functional disturbance must precede gain in the general condition. This advances the argument at the same time that the nervous derangement is of more immediate significance than the tuberculous infection. It is decidedly more rational to regard the tuberculous involvement as the factor of essential importance. Insomnia and other nervous disturbances in pulmonary invalids indicate an especial necessity for strict supervision of the details of management, the environment, and mode of life.

NERVOUS ENERGY

There is a vast difference in the degree to which pulmonary invalids retain their nervous energy. This does not always vary in accordance with their physical endurance, nor with the progress of the pulmonary disease. Some exhibit an astonishing vitality almost to the very end, although their physical strength may be impaired very seriously. This disproportionate energy may often be observed, despite the existence of considerable dyspnea, loss of weight, fever, and night-sweats. It must not be assumed that the inordinate nervous vigor of such people is due to the influence of the disease itself. As a matter of fact, it exists in spite of advancing tuberculosis. Some individuals who have been endowed by nature with an excess of nervous force retain a surprising degree of vital energy notwithstanding the unceasing drain incident to pulmonary tuberculosis. It must be admitted that in many cases the overflow of nervous energy is simulated rather than real, as some patients, in their transparent effort to deceive themselves, manifest an undisguised pride in their show of apparent strength. Upon the other hand, many invalids early exhibit pronounced nervous debility.

There is no stimulating effect upon the nervous system inherent to pulmonary tuberculosis. On the contrary, impairment of nervous energy usually results. Often this precedes loss of physical capacity, and sometimes the appearance of symptoms referable to the tuberculous invasion. Many patients complain of lassitude, indisposition, fatigue, loss of ambition, and extreme weariness for months before the appearance of cough, fever, or other manifestations distinctly suggestive of consumption. They usually awaken in the morning more or less tired, having secured no refreshing invigoration from their sleep. It is an effort for them to get out of bed, they do not enjoy work, their usual vocations appear distasteful, and minor obstacles are magnified to large proportions. They are often unable to think consecutively, the power of mental concentration being diminished to a considerable extent. They frequently lack decision or will power, and vacillation is sometimes quite apparent. Upon the definite clinical onset of pulmonary tuberculosis these evidences of impaired nervous force increase with the advance of the disease. It is not unusual to observe a very manifest disinclination to go out-of-doors, some invalids preferring to remain in the house and die comfortably rather than to make an effort to secure fresh air.

CHAPTER XXV

SYMPTOMS REFERABLE TO THE GENITO-URINARY TRACT

Tuberculosis of the genito-urinary system will be found discussed in some detail under Complications. Non-tuberculous nephritic disturbances are considered in connection with Mixed Infection. A description of the symptoms of accompanying renal disease, as well as

those pertaining to tuberculous infection of the genito-urinary tract, therefore, will not be detailed in this chapter.

The various forms of nephritic disturbance are by no means uncommon in pulmonary tuberculosis. There often exist distinct degenerative changes of amyloid character, acute and chronic involvements of the parenchyma, and the chronic interstitial variety of kidney disease. There are frequently no symptoms of the chronic forms of nephritis until the condition is far advanced, the diagnosis being secured only through periodic examinations of the urine. Very often, in the course of routine examinations, I have found albumin in the urine long before the appearance of any symptom suggestive of the kidney involvement. Hyaline and granular casts have also been recognized in many cases, sometimes before the appearance of albumin. Attention will be directed in another chapter to the frequent detection of tubercle bacilli in the urine of pulmonary invalids. Animal experimentation has shown that inoculation with the urine of consumptives, in entire absence of tubercle bacilli or suggestive clinical manifestations, is followed in many instances by the death of the animal from tuberculous infection. The symptoms of renal disease vary, of course, with the nature and extent of the nephritic change. It is noteworthy that such manifestations as dyspnea, increasing pallor, diminishing strength, slight edema of the hands, face, or ankles, are commonly attributed to the pulmonary infection, although caused in many cases by an unrecognized involvement of the kidneys. There are often present digestive disturbances as well as changes in the pulse, which may become of high tension. While patients, as a rule, may be expected to succumb comparatively soon after the development of marked renal disease, some, irrespective of the nature and extent of the pathologic change, may linger during a prolonged period of time. I have in mind a man, thirty-four years of age, a patient of Dr. Hugueley, of Atlanta, Ga., who was sent home to die five years ago on account of advanced pulmonary phthisis complicated by chronic nephritis of nearly three years' duration. I recognized the presence of chronic Bright's disease in August, 1900, and was unable to note evidence of substantial improvement at any time during the following two years. In the fall of 1902 there was extensive active involvement of both lungs, with abundant excavation in each, and moderate cardiac hypertrophy. The urine was invariably diminished in quantity and of high specific gravity. There was an enormous amount of albumin, with numerous casts of the hyaline and small granular varieties, as well as occasional leukocytes and blood-cells. Edema, cyanosis, and dyspnea were marked. The patient shortly afterward underwent a double renal decapsulation in the hands of Dr. Edebohls, who reported the results of examination as follows: "Face, anemic; lips, livid. Large cavity and wide-spread infiltration in anterior portion of right lung, middle and lower lobes; smaller cavity with surrounding infiltration in left lung, middle of anterior portion. Râles abundant everywhere over both lungs. Heart hypertrophied, with apex-beat displaced to right; no murmurs. Neither kidney palpable. The urine contained 30 per cent. of albumin by bulk, and was loaded with casts. It looked like a hopeless case from any point of view, and the patient was so informed." The operation was performed under nitrous oxid and oxygen in October, 1903. The patient is still alive, and enjoying an active business career in Georgia. Not long ago I had opportunity to

examine him while on a brief visit to Colorado. The urine is diminished in amount and contains a large quantity of albumin and innumerable casts. No essential change was noted in the pulmonary condition. It is difficult to realize how life has since been maintained in view of the physical condition of the lungs five years ago, and the complicating renal involvement. His ability to be about on his feet since then has been an ever-recurring source of wonder. I have learned recently of a severe uremic attack which took place at his home, but from which he is now convalescing satisfactorily.

The various forms of chronic kidney disease have been observed to attend more frequently the long-standing cases of consumption exhibiting cavity formation and excessive wasting. Often temporary albuminuria is found coincident with large pleural effusions, acute bronchopneumonia, or high fever from any cause.

Acute nephritis is not especially uncommon among consumptives. I have seen it follow an influenza infection, and in several instances a comparatively mild tonsillitis. Nine years ago a gentleman with extensive double pulmonary tuberculosis developed a most severe nephritis immediately following a trifling tonsillitis. The acute symptoms persisted during a period of nearly two months, and, contrary to all reasonable expectation, the patient finally made a complete recovery in spite of a long-continued uremic condition.

In 1901 a patient of Dr. Tyson suddenly developed acute uremic symptoms almost immediately upon arrival in Colorado. She remained *profoundly unconscious* for *twenty-three* days, and finally recovered. Several other equally striking instances can be enumerated to illustrate the occasional development of severe acute nephritis following apparently trifling causes.

With reference to the sexual organs, perhaps the most frequent clinical phenomenon in consumptives is the disturbance of menstruation. As the disease advances, this function is subject to considerable derangement, which becomes the source of much anxiety and apprehension to the patient. At first the menstrual discharge is noticed to be scanty and of pale appearance. It subsequently becomes delayed, irregular, more scanty, with less color, and finally disappears altogether. As the condition improves with gain in strength and nutrition these symptoms reappear in an inverse order. The menstruation often becomes entirely normal even after its suppression during protracted periods. I have known its reappearance after the lapse of two years.

It is a common belief that the sexual desire in consumptives is increased to a considerable extent, but this opinion is scarcely borne out by the facts. As far as the pulmonary involvement itself is concerned, it can be maintained that no such influence obtains. A partial explanation, however, is found in the essentially passive existence, absence of diverting thoughts, the abundant use of raw eggs, and the daily administration of strychnin. In some cases the procreative power persists almost to the point of death, but, as a general rule, the sexual appetite is diminished correspondingly with the increasing exhaustion. The fact that a few exceptional patients retain their vigor in spite of advanced tuberculosis constitutes no argument capable of general application with reference to any stimulating influence of the disease.

SECTION II

COURSE, VARIETIES, AND TERMINATION

CHAPTER XXVI

THE CLINICAL COURSE

THE course of pulmonary tuberculosis is subject to a degree of variation unequaled by any other disease. The wide diversity of clinical manifestations among different invalids is responsible for essential differences in the general type, duration, and termination. The general symptomatology, however, is so varied in character, and the course so susceptible of change from time to time in the same individual, as to preclude an arbitrary classification into separate groups. It has been customary to recognize two chief forms of pulmonary tuberculosis—the florid galloping phthisis, or "quick consumption," and the chronic form popularly described as "old-fashioned consumption." A distinction based upon pathologic changes affords further subdivision into three stages, *i. e.*, incipient infiltration, softening, and excavation. These differences in the stage of the disease, though technically capable of pathologic definition, as a rule, are not sufficiently uniform to permit an accurate clinical differentiation. In some patients the type may be defined distinctly from beginning to end, and the various stages separated from one another by sharp lines of clinical demarcation. Other cases, far from pursuing an unvarying course, are characterized by abrupt and varied changes. In addition to the decided complexity of subjective and objective manifestations there is often a striking divergence in the nature and extent of pathologic conditions. Areas of arrest may exist in immediate juxtaposition to active destructive processes. Within a relatively small region may be found, severally, an incipient infiltrative deposit, an area of secondary bronchopneumonia, one of caseous degeneration, one of complete fibrosis, and one of pulmonary excavation, with or without a surrounding zone of reactive inflammation. An explanation of the subtle variations in type, and the sudden transformation of the course, is found in the further dissemination of bacilli, differences in the absorptive capacity for toxins, and the development of wholly unexpected complications.

Owing to the intricate character of the finer histologic processes and the varying changes in the gross pathology, it is easy to comprehend the wide range of possibilities in the duration and clinical course. The morbid changes produced by the distribution of tubercle bacilli to previously uninvaded areas vary according to the number and virulence of the bacilli and their association with other microörganisms. Thus the agents of secondary infection may produce sharp exacerbations of fever, with associated disturbances, and occasionally scattered areas of pneumonic consolidation. Often the effect of such pathogenic microörganisms as the micrococcus lanceolatus, the streptococcus pyogenes, the staphylococcus aureus, or the bacillus pyocyaneus is

sufficient to turn apparent success into disheartening failure. It is well known that conditions existing in the periphery of a tuberculous focus materially influence the rapidity and extent of toxic absorption. The toxins may be sufficiently irritant in character to set up a reactive inflammation, which, in turn, constitutes a barrier against further extension of the infective process. Cornet has called attention to a direct relation, conceived to exist between the degree of absorption and the amount of poisonous material in the immediate environment of the tuberculous focus. He believes that the toxins adjacent to the area of infection, if not absorbed too rapidly, may aid, through their irritant action, in compressing the lymph-channels and partially obliterating the smaller blood-vessels. This presents certain obstacles to the extension of the bacillary infection and controls to some extent the further absorption of the poisons. If absorption is obstructed in this manner, the toxins remain in close proximity to the tubercle, and at this point exert their influence upon the tissues. It would appear that a lessened absorptive capacity aids in the formation of an inflammatory wall around the focus of infection. This barrier still further lessens the opportunities for absorption and guards against further distribution of the bacilli. The degree of absorption and the pathologic change in the periphery are, therefore, more or less interactive in their effect. According to the indestructibility and imperviousness of the barrier will absorption of toxins and egress of tubercle bacilli be prevented. These are factors of the utmost importance in determining the character of the clinical picture, which necessarily is modified in accordance with essential histologic and bacteriologic changes. Some cases conform strictly to the acute type, the course from the initial symptoms to the end being completed in a relatively short period. Others present throughout the disease features of indefinite chronicity, to the exclusion of acute exacerbations or intercurring complications. There still remains a large class who exhibit at recurring intervals widely differing aspects of the affection. In this group of cases the impression received by the medical attendant regarding the probable prognosis may be either favorable or unfavorable, according to the particular time of observation. It may be stated that, as a rule, the general character of the clinical manifestations at one period of the disease affords no reliable criterion as to the nature of the subsequent course. An abrupt development does not augur necessarily a short duration, nor does a subacute onset presage a chronic prolongation of the disease. As a result of judicious management, reinforced by individual powers of resistance, initial acute symptoms may become subject to satisfactory control, while cases apparently destined to a prolonged period of invalidism are brought to a sudden termination by the supervention of alarming manifestations. The possibility of pulmonary hemorrhage, like the sword of Damocles, must hang over the head of the consumptive, irrespective of the previous history, the character of the clinical symptoms, the apparent pathologic condition, or the duration of the disease. Cases characterized by an acute pneumonic onset and those of general miliary invasion are the least likely to undergo a change in the subsequent progress. Their duration may be from four to ten or twelve weeks. Many such patients, after the lapse of four or five weeks, have sought to avail themselves of climatic influence and have survived but a few days after arrival in Colorado. The inference has been that the exhaustion and

hardship of the journey, in connection with the sudden change of altitude, have hastened a fatal termination. Scattered or confluent areas of bronchopneumonia ingrafted upon an existing pulmonary tuberculosis frequently render the disease of short duration. The consolidation sometimes extends with relentless rapidity to a massive involvement, and clearly points the way toward the end of the journey. Death may ensue in a week or ten days, owing to the functional incapacity of the lung and the exhaustion incident to the toxemia. In some instances the patient may not succumb until after several weeks, during which time evidences of softening and excavation are recognized. The shortening of the course through the influence of secondary infection is usually less conspicuous than from pulmonary hemorrhage or pneumonic consolidation.

It is extremely difficult to generalize concerning the duration of the disease. This has been variously stated by observers to be from two to seven years, yet many cases are known to survive but a few months, and others to linger for fifteen or twenty years. The latter often present from time to time undoubted evidences of active tuberculous involvement. There has been no uniform basis for the computation of statistics, and the results must necessarily vary according to the character of the cases comprising the material from which various analyses are collaborated. The social condition of the patient, the later environment, and the opportunities for enforcing a strict régime constitute important determining factors. Cases of incipient character admitted to sanatoria, permitted to remain for considerable periods, and subjected to educational influences may be expected, in comparison with other pulmonary invalids, to show but slight lessening of longevity. The experience of other observers, many of whose patients conform to an advanced type, is, of course, entirely different. The deduction is inevitable that the duration of pulmonary phthisis in most cases is dependent upon the available opportunities to secure arrest. Not infrequently the character of the clinical course is largely a matter of personal equation. A large majority of the intercurring complications and retrogressions are occasioned either by the ignorance and superficiality of the physician, or by the stubbornness and frivolity of the invalid. The willingness and ability to avoid the sins of omission and commission on the part of the consumptive are most potent factors in modifying the course of the disease.

CHAPTER XXVII

SPECIAL VARIETIES

In addition to the ordinary forms of ulcerative phthisis which have been described, other varieties of pulmonary infection are sometimes observed presenting such peculiarities in the clinical course as to justify separate classification. There are three special forms which are strikingly different in their general aspects from the ulcerative type. The first is fibroid phthisis, characterized by an overgrowth of fibrous tissue

originating from tuberculous invasion either of the lungs or of the pleura, and followed by extensive pathologic changes involving the pulmonary tissues, walls of the bronchi, and the circulatory apparatus. The second is pneumonokoniosis, usually owing its inception to an inhalation bronchitis which, in turn, is followed by emphysema, fibrous tissue change, disturbance of circulation, and ultimate tubercle deposit. The third is the pulmonary form of general miliary tuberculosis, in which the bacilli are distributed through the blood-stream, the resulting tubercles literally studding extensive portions of the lung. This form of pulmonary invasion will be considered in connection with General Miliary Tuberculosis. Brief mention should be made of fibroid phthisis and pneumonokoniosis coëxisting with pulmonary tuberculosis.

FIBROID PHTHISIS

The term fibroid phthisis should be applied only to cases of extensive fibrous tissue proliferation emanating directly from a primary tubercle deposit in the lung or pleura. On account of accompanying pathologic changes in the lungs, bronchi, and vascular system, the symptom-complex rarely conforms to the clinical picture of pulmonary tuberculosis. Tubercle bacilli may be unrecognized in the expectoration, or detected only in small numbers, although present in the pulmonary tissues. Inasmuch as a preëxisting focus of infection represents the underlying cause of fibroid phthisis, the propriety of classifying the condition among the several forms of pulmonary tuberculosis is at once apparent. In order to avoid confusion, the fibrous tissue change of non-tuberculous origin should be described as pure cirrhosis of the lung or chronic interstitial pneumonia.

In fibroid phthisis the tubercle deposit finally becomes of secondary importance in comparison with the anatomic changes resulting from the primary infection. The symptoms referable to the early tuberculous invasion either disappear entirely or become subordinate to the preponderating fibrous tissue formation, with its associated functional disturbance. The entire clinical course is dominated by the influence of the fibroid overgrowth permeating the pulmonary tissues. The duration is much longer than that of ordinary consumption, the invalids in many instances surviving for astonishing periods despite excessive emaciation and respiratory incapacity. Improvement, even under favorable conditions, is correspondingly slow and disappointing. There is usually but little if any fever, but the pulse is often accelerated perceptibly and of poor quality. The cough may be comparatively slight, but, as a rule, is somewhat frequent, dry, and paroxysmal. The expectoration in most instances is scanty or entirely absent, but if at all copious, is more likely to be light and frothy than purulent in character. In the presence of bronchiectatic cavities, however, the expectoration is often distinctly purulent and the cough markedly paroxysmal. In such cases there is sometimes imparted to the breath of the invalid and to the expectoration a particularly offensive odor. Digestive disturbances and impairment of appetite are frequent. A beginning shortness of breath gradually progresses to the point of true dyspnea, and an early pallor may finally merge into varying degrees of cyanosis. The terminal phalanges become clubbed in the characteristic manner previously described.

It is scarcely necessary to review the physical signs other than to allude to the conspicuous deformity of the chest-wall resulting from the pulmonary and pleural retraction, the diminished vocal resonance and fremitus occasioned by the pleural thickening, the lessened resonance upon percussion, and the reduced intensity of the respiratory sounds upon auscultation. There may be areas of bronchial or broncho-vesicular respiration, and over the site of large bronchiectases, typically cavernous breathing. A distinguishing auscultatory characteristic, aside from changes of quality, pitch, and rhythm, is the diminution of the breath-sounds incident to lessened respiratory excursion and excessive pleural thickening. As stated elsewhere, the heart is almost always pulled more or less toward the affected side, or dislocated upward by reason of contraction changes involving the mediastinal pleura. Occasionally it is dilated in later stages. Reference has been made to the visible pulsation from the second to the fourth interspaces in case of left-sided involvement. The extreme chronicity of the course, the occasional absence of the bacilli, and the infrequency of fever, together with the energy and vitality displayed in spite of excessive emaciation, serve to characterize definitely this form of pulmonary tuberculosis.

PNEUMONOKONIOSIS

In pneumonokoniosis the pathologic changes may closely simulate those of fibroid phthisis. An essential difference relates to the etiologic relation of the tubercle bacillus to the accompanying anatomic condition. The tubercle deposit is in no sense a causal factor in the production of pneumonokoniosis, but takes place merely as a terminal infection. The primary cause consists chiefly of an inhalation bronchitis through continuous exposure to the palpable dust incident to certain occupations. It differs clinically from fibroid phthisis in that the course of the disease is of much shorter duration, and the fibrous tissue proliferation usually not so extreme, with less resulting deformity of the chest. The ingrafting of the tuberculous infection upon a suitable soil, represented by a weakened general resistance and increased vulnerability of tissues, affords opportunity for comparatively rapid progress. In miners, grinders, and stone-cutters, once the tuberculous character of the infection is clearly established, I have been unable to discover that the symptoms differ very essentially from those of ordinary pulmonary tuberculosis.

I have been privileged to observe a moderate number of cases of pneumonokoniosis with accompanying tuberculous infection among the gold-miners of Colorado. In the very midst of all stages and conditions of imported pulmonary tuberculosis in Denver, there are found numerous cases of miner's phthisis, difficult of differentiation from consumption, yet scarcely identical with it. There are certain etiologic factors pertaining to the condition which lend a more or less unique character to this class of cases. As stated in connection with Differential Diagnosis, these patients may exhibit all the symptoms and signs of pulmonary tuberculosis, and in the later stages show the presence of tubercle bacilli, although the latter do not represent a factor of causative significance. This class of cases is regarded by the laity, and, unfortunately, to some extent by the profession, as a form of consumption, and many such patients are classified as tuberculous in official mortality

records. Instances of pneumonokoniosis are frequently cited to illustrate the alleged development of indigenous tuberculosis in spite of favorable climatic conditions. The actual morbid processes consist of a more or less severe chronic bronchitis, emphysema, bronchiectasis, varying degrees of pneumonokoniosis, with often genuine cavity formation resulting from anemic necrosis, and secondary circulatory disturbances. The tubercle deposit, if present, is often quite insignificant in comparison with accompanying pathologic changes. These cases are found to develop almost exclusively in sections of the State devoted to the mining industry, *i. e.*, in sparsely settled regions on mountain sides where tuberculosis seldom exists. Predisposing causes are found in the prolonged hours underground and the constant breathing of an atmosphere, not only deficient in oxygen, but vitiated by impurities. The air, not being in motion, becomes more or less devitalized and is breathed over and over again. In addition to the partial asphyxiation and the frequent extreme dampness, exciting causes relate to exhalations from the candles confined within a relatively small air-space, and the smoke resulting from the blasting powder, which is difficult of complete removal despite modern efforts toward ventilation. The necessarily constrained position during the greater portion of the day, the frequent wetting of the feet, the alcoholic habits, immoderate exercise at high altitudes, and the unhygienic surroundings when not at work, constitute important supplemental features. The conditions are quite dissimilar to those obtaining in the production of coal-miner's consumption, stone-cutter's disease, grinder's or potter's phthisis, and the like, in that the sole essential factor is not the irritation produced by the inhalation of fine particles of dust. Chronic catarrhal processes take place in the bronchial mucous membranes, followed by emphysema which results from nutritional changes in the pulmonary tissues, and from an increased intra-alveolar pressure during violent attacks of cough. Moderate fibrous tissue proliferation is superinduced in some cases, but by no means to the extent observed among followers of other occupations responsible for the production of pneumonokoniosis. While the distinguishing feature is the chronic bronchitis and emphysema, there frequently supervenes bronchiectasis, both of the cylindric and saccular varieties. Its development is due in part to the frequent paroxysmal cough, the weakening of the bronchial wall from emphysema, and the more or less continuous pressure exerted by stagnating secretions. The bronchiectatic cavities correspond largely to the fibrous tissue proliferation and the contraction changes external to the bronchial wall. Through the process of ulceration of the mucous membranes these bronchiectases may be transformed into genuine pulmonary cavities. These may develop also by reason of necrotic softening of the tissues, more particularly when the pneumonokoniosis is pronounced. In this event they are more likely to increase in size and have greater bearing on the subsequent course, especially if communicating with a bronchial tube. Secondary to the pulmonary changes there ensue marked circulatory disturbances, manifested by venous engorgement and enlargement of the right heart.

Symptoms referable to this group of chronic pathologic conditions are of gradual development and relate chiefly to dyspnea, cough, and expectoration, followed by loss of weight and strength, with gradually increasing cyanosis. The cough is frequent and unattended at first

with much expectoration. Later it becomes more distressing and paroxysmal in character, particularly after the formation of bronchiectases or pulmonary cavities. There exists no definite relation between the degree of bronchial irritation and the extent of fibroid change in the lung. The sputum is frequently quite frothy, light, and *devoid of pigmentation*, becoming more purulent with the increasing periodicity of cough. Under these conditions the characteristic separation into distinct layers may be noted. Little of practical value attaches to its bacteriologic examination, save that the occasional presence of tubercle bacilli denotes a final incidental complication.

The dyspnea, which at first is noticeable only upon slight exertion, becomes progressively worse, until the patient is induced to seek relief at lower elevations.

The cyanosis is usually out of proportion to the physical evidences of cardiac and respiratory embarrassment. Impaired appetite and digestive disturbances result in diminished nutrition, increasing weakness, and night-sweats. There is rarely any elevation of temperature save during temporary acute exacerbations.

Hemorrhages are not infrequent, and may vary from slight bloody discolorations of sputum to a sudden fatal loss of blood.

The physical signs upon inspection may consist of the characteristic changes in the configuration of the thorax commonly ascribed to emphysema, with frequent unilateral or bilateral retraction of the apices and occasional capillary dilatation upon the chest front. There are often percussion-signs of partial consolidation at the apices, but in many cases the resonance is intensified and somewhat tympanitic throughout the entire pulmonary area. Fine and medium-sized moist râles may be heard in all portions of the lung, though more frequently at the bases and almost always on each side. The breath-sounds are invariably somewhat diminished in intensity, corresponding to the degree of emphysema. The dulness is occasionally unilateral, in which event there often are localized changes in pitch, quality, and rhythm, and bubbling râles. Signs suggestive of pulmonary cavities may be recognized in almost any portion of the lung, as in tuberculosis. There is no invariable predilection as to the site of the cavity formation.

In comparison with simple chronic bronchitis and emphysema, or with ordinary cases of interstitial pneumonia, the course of the disease is short, rarely lasting over four or five years. This may be accounted for to some extent by the influence of altitude, the usual unwillingness and inability of patients to avail themselves of change of residence, and their greatly diminished resistance from habits of dissipation. While considerable relief is usually experienced on going to lower elevations, the unfortunate issue is delayed but temporarily, the prognosis almost always being unfavorable.

CHAPTER XXVIII

TERMINATION

STRICTLY speaking, the ultimate termination is recovery or death, but a large number of cases cannot properly be included in either class. While not actually cured, they are none the less enabled, for indefinite periods, to pursue a life of useful endeavor within the bounds of considerable physical activity. In its technical sense complete recovery is relatively infrequent save in the most incipient cases, as the infected area is scarcely capable of restoration to its previous condition. The very conception of an enduring arrest carries with it the necessity of fibrous tissue proliferation and encapsulation, but it is unreasonable to deny, because of resulting anatomic change, the attainment of complete recovery. A permanent arrest of the tuberculous lesions is no less a cure despite a remaining indurative process than recovery from variola with resulting facial blemishes. It is entirely warrantable to regard patients as cured who, during a period of two or three years, present no physical signs of even a dormant infection, exhibit no subjective symptoms, and display an invariable absence of tubercle bacilli. It is not contended that bacilli may not exist in the pulmonary tissues of such patients, but the non-development of any signs or symptoms suggestive of their presence during a prolonged period may be construed as sufficient evidence of their practical surrender. Many patients fail to succeed in the acquirement of complete arrest, and yet possess undiminished vigor and activity. It is common in health resorts to observe a large class of individuals who have achieved apparent arrest of the active process. Many of these with entire disappearance of subjective symptoms exhibit renewed energy and industry, yet at intervals display a few apical signs, with attenuated bacilli in the expectoration. I have under my care several patients who have remained in Colorado for thirty years or more, and who present every outward and physical manifestation of perfect health, although occasionally submitting bacteriologic evidences of a remaining quiescent deposit.

MODES OF DEATH

For some unexplainable reason death from consumption has ever been thought to be particularly horrible and revolting. It is possible that the idea of a lingering illness, a so-called "dying by inches," has suggested to the popular mind an exaggerated notion of the physical distress during the final agony. There is no reason to believe that the dissolution of the consumptive is attended with a greater physical struggle or mental anguish than is experienced by other victims of the grim destroyer. In many cases the prolonged duration of the illness, rather than making death harder to bear, is instrumental to a degree in preparing the sufferer to bear the inevitable with fortitude and resignation. With many the end is a welcome relief from the burdens and hardships incident to their illness. Patients of this class, far from approaching their demise with fear and trepidation, long for eternal rest with a courage and calmness incapable of simulation.

Many times have I been impressed most profoundly by the remarkable resignation of the consumptive, who, with unclouded intellect, has responded to the last summons. It has appeared that the very nature of the illness has tended to dispossess the end of its ordinary terrors, and to render the anticipation of the supreme moment but a deferred solace for bodily ills. Many, it is true, preserve a demeanor of indifference in the face of impending death, while others, with halting tread and protestation, are dragged to their doom. Fortunately, mental hebetude sometimes comes to the rescue, followed by mild delirium and coma, and the patient sinks gently to the final sleep. The demise of the consumptive, as a general rule, is singularly quiet and peaceful, devoid in large measure of the struggle and anguish characterizing a fatal termination of other diseases. It has been my observation that the only conspicuous deviation from this manner of departure occurs among pulmonary invalids overtaken by death as a result of intercurrent complications. This is particularly true in pulmonary hemorrhage, bronchopneumonia, edema of the lungs, pneumothorax, cardiac dilatation, and occasionally tuberculous meningitis.

The end may be sudden and violent, as during severe pulmonary hemorrhage. At such a time the patient is drowned in his own blood, and may expire almost immediately from asphyxiation, the suffering being but momentary. Dissolution may take place suddenly from other causes, as cardiac weakness or bronchopneumonia. I have witnessed two instances of sudden death following light percussion of the precordial region in cases of cardiac dilatation.

In bronchopneumonia of septic origin following pulmonary hemorrhages the patient is at first restless, anxious, and excitable. After a few days this changes to apathy, stupor, mild delirium, and sometimes coma. In some instances of death from aspiration pneumonia the sensorium remains unimpaired to the last, and the air-hunger becomes extreme. This may happen also in pneumothorax, and almost invariably in pulmonary edema. In such cases the suffering is more intense than can be imagined or described. Dreadful paroxysms of cough sometimes suffice to expel foamy and bloody expectoration, causing the disappearance, for the time being, of the ominous tracheal rattle.

In acute pneumothorax and in bronchopneumonia without edema there may be no expectoration whatever. At times there is insufficient strength to effect the expulsion of the expectoration, which, if present at all, sticks to the lips and dorsal aspect of the tongue or adheres tenaciously to its base and to the posterior wall of the pharynx. The mouth and lips are exceedingly dry, and the masses of sputum are extracted only by means of a cloth or swab. The struggle, which is horrible to witness or contemplate, continues without abatement until merciful death claims its own. As a general rule, however, it seems to be a beneficent provision of nature that the vast majority of consumptives, after months and years of lingering illness, are permitted to succumb to the dread disease without sthenic manifestations.

PART III

PHYSICAL SIGNS

INTRODUCTION

Pulmonary tuberculosis produces a greater diversity of morbid conditions within the lungs, and hence exhibits a greater variety of physical signs, than any other respiratory affection. There is scarcely an objective manifestation observed in the course of the various pulmonary diseases which may not be exhibited by the consumptive as a direct result of the pathologic change incident to the tuberculous process or to associated complications. Thus an accurate recognition of the physical signs accompanying the varying degrees of tuberculous infection can be secured only from a thorough understanding of the principles of physical diagnosis as applied to *all* intrathoracic disturbances. The confusion resulting from an incorrect terminology, the frequent errors of technic in conducting physical examinations, and the faulty interpretation of various combinations of physical signs are often responsible for the non-recognition of gross pathologic lesions, and suggest the expediency of introducing a preliminary section devoted to *physical diagnosis in general.* In view of the difficulties often encountered regarding many important features relating to the physical examination of the chest, it seems desirable to outline a course of procedure emphasizing the essential principles of diagnosis pertaining to pulmonary conditions.

In no other department of medicine is there demanded such a degree of skill as in the recognition of obscure pulmonary affections. In all respiratory diseases a precise conception of the condition can be obtained only through an exhaustive and systematic examination of the patient.

While during student life dispensary facilities may be depended upon to furnish the means of acquiring a more or less practical familiarity with the making of physical examinations, these clinical opportunities will scarcely suffice for a thorough understanding of the subject unless preceded and accompanied by competent instruction concerning the principles and facts of physical diagnosis. To obtain practical proficiency it is highly important that a preparatory course of didactic or text-book instruction should be provided not only as to the physical signs themselves, but as well to the rationale of their production. Thus, in addition to the recognition of abstract physical signs, the beginner should be made to appreciate the relation of the various phenomena thus observed to the morbid conditions which they represent. Although no single physical sign may be said to characterize definitely any pathologic state of the tissues within the thorax, yet the *grouping* of several associated signs in connection with essential facts pertaining to the history and symptoms, permits the differentiation of the various conditions. It is not permissible within the limited scope of this section to do other than review important features of diagnosis.

Various methods are employed for the recognition of diseased conditions by means of external evidences. Physical signs refer to objective manifestations elicited by the physician, as contrasted with subjective symptoms described by the patient. The physician utilizes the following methods of conducting a physical examination of the chest, *i. e.*, inspection, palpation, percussion, auscultation, mensuration, and succussion.

SECTION I

General Physical Signs

CHAPTER XXIX

INSPECTION

While much may be learned by inspection, the relative importance of this method of conducting physical examinations is often exaggerated, the tendency of several writers having been to overestimate its value. It is by no means impossible for one who is totally blind to be fully as skilful in physical exploration of the chest as expert examiners who are not deprived of the sense of sight. In fact, inspection may often give rise to erroneous impressions regarding physical conditions which can be removed only by careful recourse to other methods of examination. It is not infrequent for individuals to present every visual manifestation of perfect health and yet disclose important changes upon percussion or auscultation. It is equally true that others may exhibit many outward appearances of pulmonary disease, even displaying well-developed types of the so-called paralytic thorax or phthisical chest, and yet upon examination reveal no pathologic pulmonary condition. It is apparent, therefore, that inspection should be regarded strictly as an aid to the examiner supplementary to other means of physical exploration. It furnishes to some extent preliminary impressions or provisional information, which, in all cases, should be confirmed by the employment of other methods.

RULES FOR THE PRACTICE OF INSPECTION

Inspection may be employed with the patient standing, sitting, or reclining. If standing, the body should be held erect in an attitude of repose, with the weight borne equally upon each foot. The head should rest squarely upon the shoulders, which should be drawn slightly backward and held symmetrically. Care should be taken to avoid the slouching posture frequently assumed by pulmonary invalids. Equal precaution should be exercised to prevent the tendency to throw the shoulders far backward and inflate the chest, either with or without retracting the abdomen. When the patient is told to stand erect, sometimes an appearance is presented suggesting a military inspection

during dress parade. He should be taught simply to assume a natural posture. The examiner should remain between the patient and the light. It is well for the physician at first to stand some little distance from the patient, in order to appreciate better the shape, size, and form of the chest, to note irregularities of contour or other asymmetric conditions, and to study carefully changes in the frequency and character of the respiratory movements.

If the patient is examined while *sitting*, a moderately high stool or straight-backed chair should be used. In most cases a stool is preferable, the back of the chair possessing no particular advantage and often being in the way. The habit of slouching is noticed more often with the patient sitting than standing, and should be avoided in all cases. It is good practice, however, when examining the back, to have the patient incline slightly forward with the arms folded, each hand resting upon the opposite shoulder, and the elbows kept as closely together as possible. This expands the broad wings of the scapulæ, which in emaciated people are very prominent, and permits a more ready examination of the back than can be obtained in any other position.

The examination of a male should be conducted with the patient stripped to the skin as far as the waist. There can be no excuse for neglect to insist upon this procedure. With females it is not always expedient, on the score of delicacy, to demand the entire removal of the clothing. A light shawl or cape may be drawn over the back when the front is being inspected, and vice versâ. If the undershirt is loose, it may be separated in front and dropped over the shoulders, or it may be raised from below, while examining respectively the upper and lower regions of the chest.

If the examination is made with the patient *reclining*, care should be taken that the body rests equally upon the hips and shoulders, with the head but moderately elevated. Inspection of the chest with the patient reclining can be but superficial at best, and when necessarily confined in bed, this method of examination is often comparatively unimportant.

CONDITIONS INDEPENDENT OF THE THORAX NOTED ON INSPECTION

It is usually taught that inspection should be employed particularly to note the configuration and movements of the *thorax* proper.

As a matter of fact, valuable suggestions as to the general condition may be obtained through the sense of sight long before the patient has been stripped to the waist for the examination of the chest. For example, the examiner unconsciously notes the degree of emaciation, the general carriage or demeanor, and the extent of physical weakness. Great practical importance in a general estimate of the patient's condition attaches to the *facial* appearance. The first impression conveyed to the mind of the examiner usually relates to the visible changes of the face, whether healthy or unhealthy, full or emaciated, pale or flushed, sallow, cachectic or cyanotic, dull or alert, pinched, drawn, or excitable, the various shades of expression being noted at a glance. The *color* of the face is always of clinical interest. Anemia is often present, particularly in cases of pulmonary tuberculosis. This is more surely detected by depressing the lower eyelid and observing the color of the

mucous membrane. Congestion of the face is frequently noted in chronic bronchitis with emphysema, bronchiectasis, in the early stages of pneumonia, and in several forms of circulatory disturbance.

Cyanosis is possessed of great significance. It consists of a purplish-blue flush, at first appearing upon the lips, tip of the nose, and the ears, but later suffusing the entire face. This may be present as a result of valvular heart lesions, with or without dilatation, myocarditis, pericardial effusion, emphysema, asthma, pulmonary edema, chronic bronchitis, and occasionally in pulmonary tuberculosis with circulatory embarrassment.

Edema of the face is often observed when no suggestion of pathologic change can be obtained upon inspection of the thorax alone. Facial edema may fail of recognition in some instances, as the clinician may not be sufficiently familiar with the contour and appearance to make comparative observations. The careful examiner, however, will usually note the slight puffiness of the eyelids, even upon casual observation. Critical inspection of the face and neck should precede the examination of the chest in all instances.

Great importance attaches to the frequency and character of the respiration, which may be observed quite accurately before the patient is prepared for a conventional inspection. While a detailed observation of the nature of respiratory movements is not possible without the removal of the clothing, it is easy, nevertheless, to recognize the presence or absence of dyspnea. This may exist either as labored respiration or merely as quickened breathing. The former is detected long before the clothing is removed, and is accompanied by more or less cyanosis, with an increased play of the auxiliary muscles of respiration. Simple accelerated breathing without cyanosis and unaccompanied by the use of the accessory muscles of respiration may result from such causes as emotional excitement, fever, and exercise.

Labored breathing or true dyspnea may be dependent upon a diminished respiratory capacity of the lungs in the course of pulmonary tuberculosis, pneumonia, pleurisy with effusion, pneumothorax, and emphysema; from cardiac disturbance or from a severe anemia.

Change from the normal breathing may also be recognized in the **rhythm and sound of the respirations.** In some cases the disturbed rhythm relates solely to the changed relations between inspiration and expiration, each respiratory act, however, being identical in character with all others. At other times the altered rhythm relates not so much to a disturbance of the relation between inspiration and expiration, as to radically differing characteristics of succeeding respiratory acts. An example of the first class is the so-called asthmatic breathing, in which the inspiration is shorter and quicker than normal, while the expiration is prolonged and difficult. The most striking illustration is witnessed during an acute paroxysm of bronchial asthma, but this form of breathing is displayed to a less degree in well-marked emphysema. In the latter event the inspirations are not so short and jerky and the expirations are less prolonged and labored. In well-marked asthmatic breathing the *sound* is an element of some interest in that the respiration is decidedly wheezy in character.

The disturbance of rhythm which takes place in succeeding respirations is found in the so-called **Cheyne-Stokes type of breathing.** This form of respiration may be described as an alternating cycle of

progressively *increasing*, followed by gradually *decreasing*, dyspnea, and periods of complete apnea. In this type of breathing each act of respiration is different from the preceding or the following. The patient in the beginning of his rhythmic dyspnea breathes but little differently from normal. Each following respiration, however, becomes rapidly increased in volume and louder in intensity until the height of the dyspneic attack is reached, when the respirations diminish inversely in rapidity, volume, and intensity, to be succeeded by a complete pause or absence of respiration, called the apneic period. The entire cycle may last anywhere from half a minute to a full minute. In this type of breathing, as in the asthmatic, the disturbed rhythm is associated with an appreciable difference in the intensity and quality of the respiratory sounds.

Another class of cases exhibits a distinctly **restrained respiration,** particularly during inspiration, which is short and comes to an abrupt termination apparently before the act of inspiration is fully completed. It is usually associated with a prolonged slow and cautious expiration. This peculiarity of respiration is found principally in cases of dry pleurisy, in the very early stages of pneumonia, and as a result of intercostal neuralgia, periostitis, or trauma. The restrained or catchy respiration should be distinguished from a type of irregular breathing sometimes described as *cog-wheel* in character. While this latter form is more often detected with the stethoscope, it may be occasionally noticed upon inspection alone. The essential characteristic is simply an interruption or irregularity of the inspiration.

Another distinct type of respiration is witnessed in acute conditions among children. There is displayed a striking rapidity of the respirations, together with an audible sound upon expiration. The child breathes with a distinct grunt accompanying the expiratory act. This is highly significant of severe capillary bronchitis, penumonia, or beginning Pott's disease.

A form of respiration known as stridulous breathing may occur in children whenever there is obstruction or marked change of contour of the glottis or interior of the larynx. The stridor accompanies inspiration, and is observed in edema or spasm of the glottis, false croup, laryngeal diphtheria, and whooping-cough. The slow stertorous respiration incident to profound coma has no remarkable characteristics aside from its snoring quality and the frequent association with cyanosis.

Sighing respiration is occasionally observed following severe hemorrhage from any source, although it is perhaps more common after pulmonary hemorrhage.

INSPECTION OF THE CHEST

It is unnecessary to describe the typical appearance of a normal chest. In view of the innumerable deviations in health from any conventional type, no two chests may be said to be precisely alike, and the variety of visible conditions presented to physicians making many examinations is almost infinite. Only one chest in four has been found to be perfectly symmetric.

Clinical inspection of the chest should chiefly include attention to the size and form of the thorax, and the frequency and character of

the respiratory movements. In most cases the attention of the examiner is primarily directed to the *size* of the chest.

The Size and Shape of the Thorax.—There is a great diversity in the size of normal chests. Striking differences may result from inheritance, occupation, and from such previous conditions of health as the early existence of rickets and adenoids. The same peculiarities in respect to size are often noted in succeeding generations.

Remarkable variations are also exhibited in the shape of the thorax, no two chests presenting precisely the same outward appearance. Despite innumerable peculiarities of form, chests may be classified as short or long, broad or narrow, and deep or hollow. Although certain types are commonly regarded as suggestive of intrathoracic disease,

Fig. 5.—Paralytic chest, a rachitic feature being noted in the depression of the sternum.

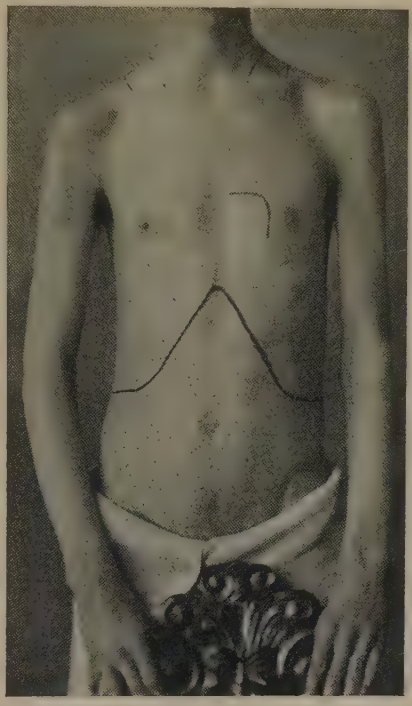


Fig. 6.—Paralytic and long type of chest. Note normal area of cardiac dulness. The areas of percussion resonance at apices are discussed on p. 226.

no presumptive conclusions as to morbid conditions are justified by external appearances. A characteristic variety is the phthisical or paralytic chest, so named because of the frequency of association with pulmonary tuberculosis. If the soft parts are considerably emaciated, the peculiar effect is to some extent emphasized. The thorax is more or less flattened anteroposteriorly, with slight increase in the lateral diameter, irrespective of the length. The sternum is sunken appreciably; the sternal ends of the clavicles are apparently pulled downward; the neck appears longer, and the chin more sharply defined with respect to the neck. The entire bony framework of the chest assumes greater promi-

nence, the ribs being more conspicuous and the intercostal spaces deeper and usually narrower. In the back the scapulæ stand out broadly from

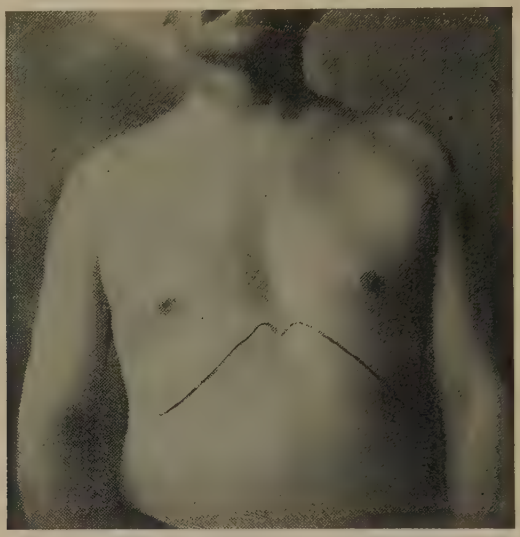


Fig. 7.—The short, broad, and thick chest.

the ribs, giving rise to a suggestive winged appearance. There is no material deviation from normal respiratory movements save under

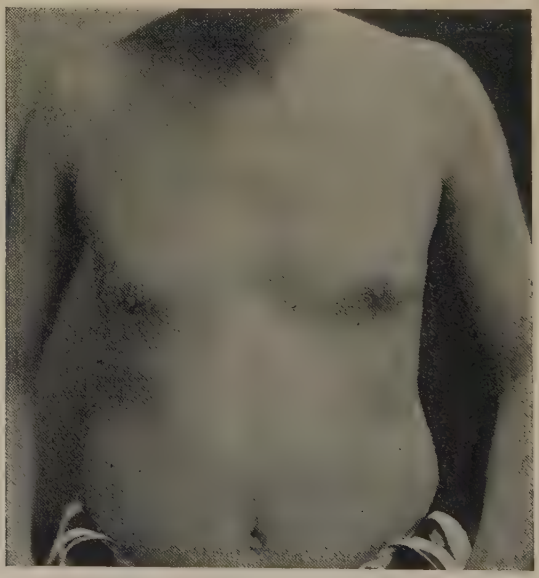


Fig. 8.—Patient in whom the physical evidences of tuberculous involvement were well defined at each apex.

exertion or excitement, when they become noticeably shallow and are somewhat accelerated.

It should be borne in mind that a well-defined "phthisical chest" is not incompatible with perfect health, and also that extensive active tuberculous change may exist within a thorax presenting a normal

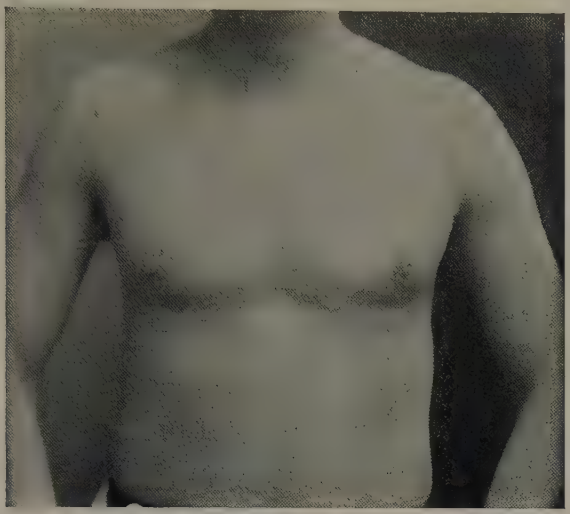


Fig. 9.—Brother of preceding. Pronounced tuberculous involvement, with signs of consolidation and moist râles, left apex to third rib, and from the right apex to second rib.

external appearance. The prominence of the scapulæ, sometimes thought to be characteristic of pulmonary phthisis, may be observed not infrequently even among healthy and well-nourished individuals. Upon the other hand, many patients with advanced pulmonary involve-

Fig. 10.—Extensive tuberculous involvement of left lung from apex to base.

ment are found to present no suggestion of a winged appearance in the scapular region. The accompanying cuts are of interest as illustrating the disproportion between the visual outlines and the physical findings.

Figs. 5 and 6 represent typically paralytic chests, although there is no physical evidence of tubercle deposit. The latter is an excellent example of the long chest, in contrast to the short type in Fig. 7. In Figs. 8, 9, 10, 11, 12, 13, and 14 are shown individuals exhibiting very

Fig. 11.—Extensive tuberculous infection of both lungs. Left, signs of consolidation with moist râles, apex to base, with cavity formation. Right lung, well-advanced tuberculous process at apex, front, and back. (Compare with radiograph, Fig. 63.)

extensive tuberculous precesses, notwithstanding every external appearance of perfect health.

In the *emphysematous chest* there is an increase of all the diameters of the thorax, suggesting a state of permanent inspiratory expansion. That the chest is broader and deeper than normal is usually recognized

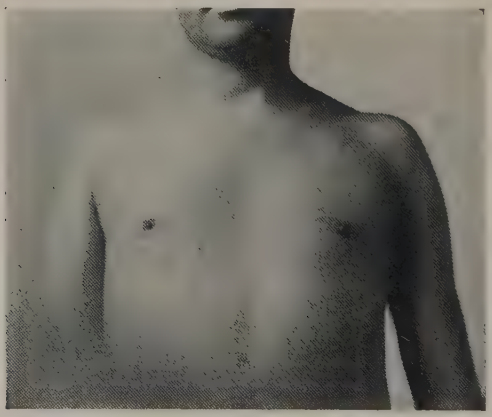


Fig. 12.—Marked consolidation with moist râles—right, apex to second rib; left, apex above clavicle. Signs of involvement in both apices in the back. Well-defined myocardial involvement.

at a glance. The shoulders and clavicles are elevated, and the neck appears materially shortened. The sternum is lifted forward and upward, as are also the ribs, which are widely separated, moving but little upon respiration. In such cases protrusion of the abdomen is noticed

upon inspiration. The rib-spaces are less conspicuous than usual, and in exaggerated types may be slightly bulging. A very considerable degree of emphysema may exist without the slightest external evidence of the so-called barrel or emphysematous type of chest. It is even

Fig. 13.—Tuberculous infection, entire left lung from apex to base, with cavity formation in upper portion. Also active involvement right apex to third rib. (Compare with radiograph, Fig. 54.)

found in the so-called rachitic and phthisical varieties. In these cases the emphysema develops late in life, when the bony framework of the chest is too unyielding to exhibit resulting changes in shape. Examples of emphysema developing in adult life are shown in Figs. 17 and 18.

Fig. 14.—Well-defined evidences of tuberculous involvement in upper portion of right lung.

In the *rachitic chest* the anteroposterior diameter is considerably increased, particularly in the upper portion, while the lateral diameter at the base is materially lessened. The sternum, especially in its upper portion, often becomes very prominent, giving rise to the familiar appearance of "pigeon-breast." The lateral retraction at the bases is sometimes marked, and is attributed to the previous imperfect entrance of

air to these parts, and to the effect of atmospheric pressure. Small bony

Fig. 15.—Representing very prominent scapulæ in the absence of tuberculous infection or emaciation.

enlargements may be seen or felt at the junction of the ribs with the costal cartilages. This line of beaded projections has been described as

Fig. 16.—Representing patient in far-advanced phthisis without winged scapulæ. Note prominence of spinal column.

the "rachitic rosary." In some cases there is a pronounced depression

Fig. 17.—Extensive emphysema in patient with moderate tuberculous involvement at right apex.

Fig. 18.—Very extensive emphysema in patient with pulmonary tuberculosis, bronchiectasis, and chronic bronchitis. Note the characteristic clubbing and thickening of the terminal phalanges typical of such conditions.

of the lower portion of the sternum, and the costal cartilages bend inward and backward to meet the ensiform appendix in such a manner

Fig. 19.—Remarkably defined funnel chest in patient with extensive pulmonary tuberculosis.

as to suggest the name of "funnel breast." A rachitic chest with funnel breast is shown in Figs. 20 and 21.

The pictures exhibited to illustrate these types of chests will afford

Fig. 20.—Rachitic type of chest and funnel breast in a patient with moderate tuberculous involvement.

a clearer conception of their striking peculiarities than any further

Fig. 21.—Side view of preceding case.

description. It should be repeated that in many instances no path-

ologic changes are found within the chest, despite the outward manifestations suggestive of disease, and vice versâ.

Unilateral Prominence of the Chest.—An entire side may thus be affected, the shoulder being elevated, the ribs lifted upward and outward, the intercostal spaces very shallow, and the scapulæ pulled upward, outward, and forward.

This enlargement of one side may be due to the presence either of *air* or of liquid in the pleural cavity. In the valvular type of pneumothorax the pleural overdistention is extreme, as the air is pumped into the cavity with each inspiration, and is not permitted to escape upon expiration, the enlargement of the affected side usually becoming well marked.

In small pleural effusions it is often impossible to recognize any appreciable change in the external appearance of the chest, but when the quantity of liquid contained within the thoracic cavity is large, the careful observer cannot fail to distinguish a disparity between the two sides.

Whenever one lung is compressed by effusion, damaged by disease, bound down by adhesions, or in a state of collapse, the other lung undergoes a compensatory emphysema. This supplemental work results in an increase of volume and in a corresponding enlargement of one side.

Unilateral Retraction.—An entire side of the chest is occasionally depressed and more or less diminished in size. Rarely this may result from imperfect development following hemiplegia in infancy. In such cases the retraction is associated with atrophy of the muscles of the

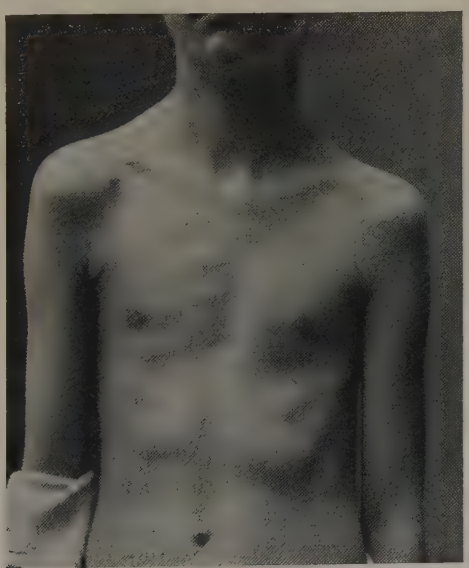


Fig. 22.—Unilateral retraction of chest following hemiplegia in infancy.

chest, as well as of the corresponding side of the face, arm, and leg. Fig. 22 illustrates this retraction very well. The subject is a boy nine years old, with extensive tuberculous infection of the left lung, who recovered after the lapse of two years, exhibiting marked fibrosis.

The retraction of the left side is not due entirely to the fibroid change incident to the arrest of the tuberculous process, for corresponding muscular changes are present in the left side of the face, arm, and leg. Diminution in the size of the chest may be produced in adult life by reason of contraction changes in the lung or pleura of the affected side. Fig. 23 represents the retraction of the left side following extensive fibrous tissue formation and supplementary enlargement of the right.

In addition to changes affecting an entire side, there are also localized deviations from the normal.

Circumscribed Prominences.—It is obvious that tumors of the soft parts may produce changes capable of ready recognition. The same is true of protuberances upon the ribs or sternum resulting from periostitis. A considerable cardiac enlargement, especially in children,

Fig. 23.—Left-sided unilateral retraction of chest.

Fig. 24.—Circumscribed prominence of chest with accompanying localized depression.

is capable of visual detection, as is also, in some instances, a pericardial effusion, an aneurysm, or a mediastinal growth. Pathologic conditions in the lungs or pleura, however, rarely give rise to any localized external enlargements. A greatly enlarged liver or spleen rarely may be recognized as a local bulging.

In Fig. 24 is shown an instance of circumscribed prominence with accompanying localized depression of unknown cause.

Circumscribed Depression.—The most important cause of circumscribed depression is the retraction of the chest-wall from localized fibroid change. The most common location is either above or below the clavicle, or both. A distinct unilateral depression in these regions is quickly noted by the examiner, and is immediately suggestive of a preëxisting tuberculous process. Localized retraction is not infrequent in the lateral region, but is not always susceptible of satisfactory explanation.

RESPIRATORY MOVEMENTS

It has been stated that much information can be gained with reference to the character of the respiration before stripping the patient for

Fig. 25.—Hard localized prominence in upper sternal region, occurring in a woman, sixty-five years of age. The growth is carcinomatous in nature, with similar involvement of mediastinum and right lung. (Compare with radiograph, Fig. 86.) On account of the physical signs of consolidation in the right lung in association with loss of weight and general prostration, the patient was sent to Colorado for supposed pulmonary tuberculosis.

inspection. It is difficult at times to form correct impressions regarding the respiration with the patient prepared for examination, on account

Fig. 26.—Showing circumscribed retraction right lateral region. Note prominence of ribs.

of nervousness and the too conscious efforts in breathing. It is true, however, that a comparison of the respiratory movements upon the two

sides is manifestly impossible without the removal of the clothing. Otherwise one is also unable to determine whether the respiratory movements are diaphragmatic or costal in character. In male adults the respiratory movements bring into play the inferior part of the chest and diaphragm. In females the respiration is frequently confined to the upper part of the thorax—the so-called superior costal variety. In children the breathing is usually diaphragmatic. A costal type of respiration may be induced in adults by any cause which interferes with the descent of the diaphragm or with the respiratory function of the lower portions of the lung, as a double pleurisy with effusion, bilateral retraction of the bases, or extensive fibroid change. The descent of the diaphragm may be impeded by the presence of a large quantity of ascitic fluid, by great distention of the abdomen with gas, or by the existence of an acute peritonitis. The inferior costal or diaphragmatic respiratory movements may be increased by causes interfering with the

Fig. 27.—Circumscribed retraction right apical region accompanying advanced tuberculous involvement. Note cicatrix from burn, which was of undoubted etiologic significance.

expansion of the upper portions of the lung. While the movements of respiration should occur at the same time upon both sides, and be perfectly equal, an increased or a diminished unilateral expansion is not infrequent in the presence of pathologic conditions.

Litten's Phenomenon.—This interesting sign in some cases is possessed of definite diagnostic value. The patient is placed in a reclining position, with the feet toward the window. The examiner stands at the side of the patient and observes upon full inspiration a shadow descending from the seventh to the ninth ribs, and receding upon expiration. This is produced by the movement of the diaphragm in connection with the descent of the lung into Gerhardt's complemental space. It is not capable of recognition whenever physical conditions prevent the fullest expansion of the lung. It cannot be detected in pneumonia of the lower lobe, moderate pleural effusions or pneumothorax, firm pleural adhesions, severe peritonitis, or ascites. Whenever

the descent of the diaphragm is not interfered with, the Litten phenomenon is of value as aiding in the differentiation of enlarged liver and pleural effusion. It is also of aid in some cases in the diagnosis of incipient apical involvement, as will be further discussed under Diagnosis.

CARDIOVASCULAR CHANGES

Any extended consideration of heart and circulatory conditions is entirely without the scope of this book. There exists, however, so intimate and reciprocal a relation between pulmonary diseases and cardiovascular disturbances that brief reference to associated heart changes is desirable.

The data to be obtained upon inspection as regards the heart and circulation are always of much interest. In some instances but little of practical value is detected, even after a searching inspection. Often the facts thus derived become of importance only when confirmed by the results of palpation and percussion.

For successful inspection with reference to the heart or circulation a careful technic must be employed. The physician must be thoroughly familiar with the possible cardiac and vascular changes, and be prepared to watch for their appearance. Upon inspection with regard to pulmonary conditions the patient is usually observed by the examiner from a distance in order to afford opportunity for a comparison of the two sides of the chest. When noting cardiac complications, however, the physician must stand much nearer the patient, and the inspection becomes a matter of closer detail. The inspection should be made with the patient both in the upright and in the reclining posture. The examiner should take cognizance of changes referable to the precordia as a whole, the apex-beat, and the epigastric region. The neck should be examined in order to determine the presence or absence of arterial throbbing or venous pulsation; the arms, for evidence of brachial arteriosclerosis; the abdomen and chest near the attachment of the diaphragm, for the recognition of capillary dilatation, and the lips, for the detection of capillary pulsation.

CHANGES RECOGNIZED IN THE PRECORDIA AS A WHOLE

Reference has been made to the circumscribed bulging of the ribs in the precordial region as a result of rickets, cardiac hypertrophy, and pericarditis with effusion in children. Protrusion of the precordial region due to these causes is not associated with visible muscular movements of cardiac origin. There may be observed at times a distinct rhythmic rise and fall of the soft parts, between the second and fourth or fifth ribs. This may be noted as a heaving impulse synchronous with the heart's action, or as a peristaltic wave or undulation. Visible precordial pulsation may be explained by the following general causes, *i. e.*, exaggerated heart contractions in thin, nervous people suffering from so-called cardiac neuroses, muscular effort, or excitement (though rare), exophthalmic goiter, simple cardiac hypertrophy with or without aortic regurgitation, and occasional arteriosclerosis.

In addition to the above conditions, which relate particularly to the heart and circulation, other causes may exist independent of cardiovascular changes. It is well known that in profound anemic states

with deficient aëration of the blood the respiratory movements are shallow and rapid. With diminished expansion of the lung a larger portion of the heart becomes denuded of its pulmonary covering and renders possible, at times, visible pulsations in the precordia. In the same way shrinkage due to left-sided fibrous tissue proliferation operates to uncover a larger portion of the heart, as well as to effect its displacement.

CHANGES RECOGNIZED IN THE CARDIAC IMPULSE AT THE APEX

The apex-beat is not produced by the very apex of the heart. The latter is situated about three-quarters of an inch to the left of what is recognized visually as the apex-beat. The anatomic apex is covered by a projection of lung called the lingula pulmonalis. The visible apex-beat is produced by the contraction of the lower portion of the right ventricle as it strikes the wall of the chest. The location of the apex-beat is described as an area about three-quarters of an inch square, between the fifth and sixth ribs, a little within the nipple. In this position there may often be seen a rise and fall of the chest-wall with each pulsation of the heart.

In corpulent individuals, and particularly in females with large mammæ, it is frequently impossible to detect any visible apex-beat whatever. In children this is found higher,—sometimes in the fourth interspace,—while in the other extreme of life it may be depressed as far as the sixth. The heart being attached at its base solely to the great vessels, may be imagined to swing to some extent as upon a pivot. This permits a considerable difference in the location of the apex upon changes in the position of the individual and other causes. Configuration of the thorax may also have an influence in changing its position.

In rachitic chests, especially with protrusion of the sternum, the apex may be found displaced slightly upward and to the right of its normal position. As a result of associated pathologic conditions the apex may be dislocated to the right or left, upward or downward. The morbid changes sufficient to produce these results may exist in the heart itself, in the pericardium, in the lungs, in the pleura, arteries, and kidneys.

The important changes in the heart sufficient to alter the location of the apex-beat are chiefly hypertrophy or dilatation.

Hypertrophy of the right or left ventricle may displace the apex-beat to the left and slightly downward. If associated with arteriosclerosis, especially in aged people, the downward displacement is considerably increased.

In pericarditis with effusion the apex is lifted and displaced slightly to the left.

Changes in the lungs may suffice to obliterate the visible apex-beat, to displace it downward or to either side. It may be obscured as a result of pronounced emphysema, the increased volume of lung interposing such a layer between the right ventricle and the chest-wall as to preclude any visible impulse. Sometimes the apex is depressed in emphysema. The cardiac impulse may be displaced either to the right or to the left, by virtue of fibroid contractions, the heart being pulled usually *en masse*, but occasionally with a conspicuous change in the position of the apex.

Pleurisy with effusion, on the other hand, pushes the heart away

from the affected side, often producing a considerable change in the location of the apex-beat. In left-sided pleurisies the apex is displaced to the right. Not infrequently in pleurisies of the right side it is forced to the left and somewhat elevated. In pneumothorax also the heart is pushed perceptibly toward the unaffected side. I have occasionally found the apex in a left-sided pneumothorax in the immediate vicinity of the right nipple. The apex of the heart may be displaced upward by changes in the abdominal cavity resulting in an elevation of the diaphragm, *i. e.*, excessive distention from gas or ascitic fluid.

A *retraction* of the chest-wall is sometimes seen at the site of the apex-beat. This is due principally to adhesive pleuropericarditis. The adhesions between the pericardium and pleura permit a drawing in of the chest-wall during systole, with occasionally a visible rebound during diastole.

EPIGASTRIC PULSATION

Visible pulsation in the epigastrium may be noted under certain conditions. Not infrequently this is observed in thin persons and in those of decided nervous temperament. In such cases the pulsation is devoid of any pathologic significance. It may be present in aneurysm of the abdominal aorta, a comparatively rare condition. The pulsation may be transmitted through a solid neoplasm affecting the pyloric end of the stomach or the pancreas, and also through the left lobe of the liver. It may exist on account of hypertrophy of the right ventricle. Usually it is easy to ascertain the precise cause of epigastric pulsation through the process of exclusion.

VISIBLE CHANGES IN THE NECK

Throbbing of the carotids is easily recognized. It is usually associated with hypertrophy of the left ventricle in connection with aortic regurgitation, producing an exaggerated pulsation also in the brachial, radial, and temporal regions. Increased arterial pulsation is noted in exophthalmic goiter, in states of arterial excitement, and as a result of arteriosclerosis. Venous pulsation observed in the neck is of comparatively little significance if presystolic in time. If systolic, it is indicative of tricuspid regurgitation. When exceedingly light pressure is made over the part where the pulsation is observed, which is usually in the lower part of the neck, and more frequently upon the right than upon the left, the pulsation immediately ceases provided it is purely venous in origin. If, however, the pulsation is arterial in character, light pressure will not cause its disappearance. If the vein is stroked from below upward and immediately fills from below, the evidence is conclusive as to the existence of tricuspid regurgitation.

Valuable data may be obtained from inspection of the arms to ascertain the existence of arteriosclerosis. The arteries are sometimes tortuous and exceedingly prominent, with marked rigidity of the walls.

The superficial blood-vessels of the abdomen may likewise be seen to stand out prominently upon the skin as a result of obstruction. More frequently there are observed small capillary dilatations which may extend like a bow across the entire front near the attachment of the diaphragm. No satisfactory explanation has been offered for their occurrence. It has not been found in constant association with recognized cardiac involvement.

While capillary pulsation, usually occurring as a result of aortic regurgitation, is sometimes capable of recognition upon casual inspection, it may be easily detected either upon the lips or under the fingernails with slight pressure.

CHAPTER XXX

PALPATION

Palpation, or the employment of the sense of touch, has been too frequently regarded as of little value in the physical examination of the chest. Although, perhaps, of less importance than some of the other methods, it is, nevertheless, of exceeding benefit to the examiner in many instances. Neglect to utilize this method of examination often entails failure to recognize physical conditions, the presence of which would otherwise be easily detected. As used for the diagnosis of respiratory diseases, it may be said, in a general way, to confirm the results of inspection. Much of the information afforded by the sense of sight can also be obtained by a carefully trained sense of touch. This I have repeatedly witnessed in observing the work of a distinguished physician deprived of his sight. In some instances certain data obtained by inspection are so definite and exact as scarcely to require the employment of palpation for their verification. Through its employment in special instances, however, information may be acquired of a more positive and accurate character than is possible from inspection. For example, the peculiar flattening of the bony thorax incident to the phthisical chest may sometimes be overlooked upon inspection on account of the thickness of overlying soft parts. Upon palpation of the upper lateral regions the prominent outward arching of the ribs is immediately noticed, and attention drawn to the flattening of the chest. As a rule, palpation of the thorax, with a view to ascertaining its shape, size, and the character of the respiratory movements, is entirely superfluous if preceded by systematic inspection.

The chief value of this method of physical examination is to elicit vocal fremitus.

The hands, which ought not to be unduly cold, should be placed upon symmetric parts of the chest. It is not necessary that much pressure be exerted, a light touch being ordinarily all that is required. In some instances, however, it is well to use moderately firm pressure when examining for vocal fremitus. Generally speaking, the palm of the entire hand should be laid upon the chest, care being taken that the fingers are not permitted to rest in the intercostal spaces. When examining a small area the tips of the fingers lightly pressed against the chest-wall yield the best results.

VOCAL FREMITUS

This sign, sometimes called tactile fremitus, refers to a distinct vibration which is imparted to the hand laid upon the chest during phonation. The vibrations emanating from the vocal bands are conducted to the

wall of the thorax by virtue of the column of air in the trachea and bronchial tubes, augmented by solid contiguous parts.

Vocal fremitus is best appreciated when the patient is instructed to repeat numerals, harshly and in a low pitch. In comparing different parts of the chest care should be taken that the spoken voice conforms to the same monotone at all times and to the same degree of loudness. The vibration is much greater in males than in females—in fact, it is often incapable of recognition among the latter. It is less pronounced in children than in adults, and much greater in those who have deep bass voices and thin chests. It is diminished by thickness of the soft parts, resulting from excessive muscular development or thick layers of adipose tissue.

The vocal fremitus varies in different parts of the chest, and there is a *normal disparity* between the vibration elicited at the two apices. It is marked at the apex, both above and below the clavicle, and in both lateral regions of the chest, particularly in the upper portions. It is also pronounced in the interscapular regions, while at the bases, over the scapulæ, and in the region of the heart, it is appreciably diminished. *The fremitus is distinctly more marked at the right apex than at the left, both in front and back, and more in the right interscapular region than in the left.*

In disease the vocal fremitus may be greatly increased, diminished, or entirely absent.

Speaking broadly, it may be said to be *increased* whenever there is within the lung a greater relative amount of solid to air than normal. Thus, in consolidation of the lung from any cause, as pneumonia or tuberculosis, the vibratory phenomenon is distinctly exaggerated. Whenever the pulmonary tissue is compressed by virtue of a coëxisting pleural effusion, the vibration is correspondingly affected. It is increased over a large superficial pulmonary cavity surrounded by indurated lung, and also in a recent compensatory emphysema because of the increased tension of the pulmonary tissues.

The vocal fremitus may be *diminished* or *absent* on account of any condition interfering with the transmission of the vibration through the column of air, or the interposition of a medium through which it must pass before reaching the chest-wall.

Among the former causes may be mentioned chiefly the occlusion of a primary bronchus from secretions, from pressure of mediastinal glands, aneurysm, or new-growths, and the collapse of lung in pneumothorax. In any of these conditions the vocal fremitus may be diminished or entirely absent, although percussion changes may not be pronounced. The respiratory sounds, like the vocal fremitus, may be lessened or absent in occlusion of the bronchus and in the closed or valvular types of pneumothorax. In very rare instances the fremitus is diminished in complete solidification of lung.

The lessening of vocal fremitus in pneumothorax is due to the utter collapse of the lung, with consequent closure of the bronchus and obliteration of the air column, and to the interposition of a layer of air between the lung and the chest-wall.

The vibrations are obstructed through the intervention of another medium, as in pleurisy with effusion, and in the presence of pleural thickenings, contractions, or plastic exudations. Adhesions may or may not facilitate the conduction of vibration in these cases.

In pleurisy with effusion the liquid does not remain at the base of the pleural cavity with its upper surface corresponding to a horizontal plane, but is molded to a certain extent around the lung, between it and the chest-wall. According to the extent and size of the effusion, the vocal fremitus is diminished or entirely absent.

In extensive pleural thickening with adhesions the vibrations are transmitted less readily on account of the interposition of solid media.

PALPABLE RHONCHI; PLEURAL AND PERICARDIAL FRICTION-SOUNDS

Although vocal fremitus is the principal physical sign capable of recognition by palpation, it is rather interesting to note the occasional detection of bronchial râles, as well as pleural and pericardial friction-sounds, by the sense of touch. The dry, harsh rhonchi may sometimes be distinctly felt upon palpation, in contrast to the fine sibilant râles heard upon auscultation.

Appreciable vibratory impressions may be conveyed to the hand as friction rubs emanating from the pleura or pericardium, but the detection of these sounds is comparatively rare upon palpation, and their recognition perfectly simple upon auscultation.

Brief mention should be made concerning the importance of palpation in examination of the heart. The position of the apex-beat may be detected in many instances when impossible of recognition by the sense of sight, and at the same time valuable information may be derived as to the character of the cardiac impulse.

In determining the size of the heart, the results of palpation are often more definite and positive in character than those of percussion. The tympanitic resonance of the stomach is often transmitted upward and to the left, interfering with cardiac percussion. By feeling carefully with the tips of the fingers at the left of the heart's apex to the furthest point where any cardiac movement is recognized, an approximate estimate can be made of the left cardiac boundary. The presence or absence of a thrill is also ascertained with the fingers laid against the precordial region. This sign is usually obtained at the apex and over the aortic valve, and has been described as similar to the sensation felt with the hand placed upon the throat of a purring cat. The thrill is usually presystolic at the apex, but in rare instances may be systolic in time.

Palpation of the blood-vessels is also important. By this means definite information is gained respecting the visible pulsations in the neck, whether of venous or arterial origin.

The degree of arteriosclerosis of the brachial arteries is appreciated more definitely upon palpation than inspection. Palpation of the radial artery is of extreme value in noting the rate, rhythm, tension, and compressibility of the pulse, and the character of the arterial wall.

CHAPTER XXXI

PERCUSSION

While inspection relates to the diagnosis of physical conditions through the sense of sight, and palpation through the touch, percussion refers to the act of tapping the chest, thus setting up vibrations which may be appreciated by the examiner through the sense of hearing. Nothing can so signally characterize the skill of the physician in physical diagnosis as ability to perform percussion. Success can be obtained only by a thorough acquaintance with the normal percussion boundaries of the various organs and by the unvarying observation of a careful technic. Failure is accounted for by lack of familiarity with the anatomy of the thorax and its contents, as well as by neglect to adhere rigidly to prescribed methods. A perfect knowledge of the principles of percussion as applied to the normal chest is a necessary preliminary to any consideration of abnormal conditions. Despite familiarity with the theory of percussion, conspicuous skill can be secured only by continued practice. It is the intelligent technic, perfected by long experience, which serves to bring forth the sound vibrations, and enables the physician to recognize important analytic differences and to acquire confidence in the results of his examination. It is not so much the possession of a keen musical ear which some regard as a *sine qua non*, as a well-trained sense of hearing with relation to the recognition of a few simple elements of sound.

The sound elicited by percussion may be regarded as either resonant or non-resonant. Whenever the air contained within aërated bodies is set in vibration by percussion, the sound produced is always resonant in character. If percussion is practised upon solid bodies, the sound is at once recognized as non-resonant, and is described as flat. Flatness, therefore, should not be included as one of the varieties of resonance. Organs containing but little air may give rise to a diminished resonance which is called dulness.

All resonant sounds may be classed with reference to four important characteristics—intensity, pitch, quality, and duration.

Intensity refers to the extent or volume of the vibrations, and is commonly classified as loud or faint. This varies directly with the force of the blow, the thickness of the intervening soft parts, and the volume of the underlying lung.

If the percussion blow is gentle, the vibratory intensity may be slight or inappreciable, while very powerful percussion tends to obscure the resonance by inducing vibrations in distant parts of the organ. A stronger blow is necessary to elicit audible resonance in some chests than in others. It must follow that the force of the percussion must be adjusted in all cases to the conditions presented at the time of the examination.

It is obvious that the intensity must vary with the thickness of the soft parts overlying the aërated lung. Well-marked muscular development and thick layers of adipose tissue diminish the loudness of the tone and require somewhat harder percussion. A lessened intensity is noted over the scapulæ because of the intervening bony formation

and the thick muscles of the back. Percussion, if attempted over a large mammary gland, is usually unsatisfactory. On the other hand, gentle percussion upon the thin chests of emaciated individuals and in children is sufficient to awaken resonance of decided intensity.

Other things being equal, the intensity is increased in proportion to the greater volume of lung on account of the larger amount of contained air. For this reason the resonance is more intense below the clavicles than above.

Pitch refers to the length of the vibrations, and is described as low when the vibrations are long, and high when they are short. *This is the most important element of sound from a diagnostic standpoint, and is often a source of great confusion to students.* It should be borne in mind that pitch bears no absolute relation to intensity. Sounds may be loud or faint, and yet have precisely the same pitch.

The lowness or highness of pitch is, of course, purely relative. The pitch obtained in all pathologic states within the thorax is higher than in a normal chest. For the sake of convenience, the pitch in health should be described as relatively low. As there takes place a greater relative amount of solid to air in a given portion, the resonance becomes dull and higher in pitch. The pitch may also be elevated upon percussion over bodies of air, but this is accompanied by change in quality.

Difficulty is usually found in describing precisely what is meant by the *quality* of a sound. It refers to a peculiar character of the vibrations, dependent upon the precise construction of the air-containing body in or from which the sound is produced. Thus the quality of the sound produced by the flute, the piano, the violin, etc., varies according to the detailed construction of the instrument from which the sound is emitted. The quality of the sound from a piano, for instance, cannot adequately be described to a person who has never heard it, yet one who has been familiar, even to a slight degree, with musical instruments can recognize instantly the sounds produced by a piano or other instrument in an adjacent room, not because of their intensity or their pitch, but wholly as a result of their peculiar individual quality. The pitch may be high or low, the sound may be loud or faint, and yet no difficulty is experienced in differentiating its quality or character. As the quality of tones emitted by musical instruments is dependent entirely upon peculiarities of structure, so the character of the sound obtained by percussion of the normal chest is incident to the anatomic construction of the air-containing organs. The term "vesicular resonance" naturally has been given to the vibrations emanating from the air-vesicles of the normal lung. This is to be distinguished from the so-called "tympanitic resonance" obtained upon percussion over large bodies of air. All resonance is either vesicular or tympanitic in quality. As the quality changes from vesicular to tympanitic, the pitch is correspondingly higher.

In comparison with intensity, pitch, and quality, *duration* is of but slight importance as an element of percussion resonance, although of great value in the analysis of auscultatory sounds. Generally speaking, the duration of the vibrations increases with the intensity and diminishes with the elevation of pitch.

To elicit intelligent percussion resonance certain methods of procedure should invariably be followed.

RULES FOR THE PRACTICE OF PERCUSSION RELATING TO THE PATIENT AND TO THE EXAMINER

Rules for the Patient.—The patient, whether sitting or standing, should be in an attitude of repose. The shoulders should not be thrown too far back, and the muscles of the neck or chest should not be put in a position of undue tension. It is necessary that the shoulders and arms be held symmetrically. The head should not be inclined to either side, and the face should be directed straight ahead. It is sometimes permissible for the face to be turned slightly to one side while percussing at the apex, particularly if there is noticeable retraction at this point. Opportunity is thus offered for more satisfactory percussion. Care should be observed, however, to avoid turning the face or inclining the head *sharply* to either side, as this gives rise to overstretching of the muscles and consequent interference with percussion resonance. It is often desirable that the patient should sit during percussion, and rest the back against a straight-backed chair. In examining the anterior axillary region the arm may be drawn slightly backward, and in percussing the posterior lateral region the arms may be held a little to the front. When the back is examined, the patient should fold the arms, placing each hand upon the opposite shoulder, with the elbows held as near together as possible in order to spread the scapulæ. This is particularly important in emaciated people. The patient is then requested to lean slightly forward, rounding the shoulders and upper part of the back like a bow. If the patient is examined in bed, attention should be paid to the maintenance of a symmetric position of the shoulders and hips.

Rules for the Physician.—These refer to the avoidance of percussion instruments, to the position of the pleximeter finger, the manner in which the blow is dealt by the hammer finger, and the position of the examiner himself.

Avoidance of Percussion Instruments.—It is almost unnecessary to state that the student and practitioner should dispense entirely with all mechanical devices for the purposes of percussion. None of the instruments of varied form and character has been found equal to the fingers of the examiner. It is much easier to avoid beginning the employment of pleximeters and hammers, than it is to be compelled to dispense with their use subsequently. Those who are skilled in percussion with the fingers rarely, if ever, need resort to mechanical appliances. On the other hand, those who are accustomed to these instruments are sadly handicapped when obliged to percuss with their fingers. The only possible advantage of pleximeter and hammer in any case is to increase intensity, but the actual need for this seldom exists. In many instances their use is contraindicated because of inability to apply the instruments to small localized areas. Thus, in emaciated individuals, with prominent ribs and sunken intercostal spaces, the pleximeter cannot be perfectly adapted to the surface of the chest. It is also impossible, by the use of these devices, to distinguish finer differences in sound when percussing from the ribs to the intercostal spaces. In children their use often serves only to frighten the child and to render the examination more difficult.

Percussion with the fingers, however, is not attended with any of the disadvantages of pleximeter and hammer, and in many cases affords

a distinct aid to the examiner. The fingers are not lost, broken, or forgotten, and can be applied to any portion of the chest, and rarely frighten even the most timid child. An opportunity is afforded to appreciate the resistance of the part percussed, which, of course, is impossible with any other form of plexímeter.

The Position of the Plexímeter Finger.—Especial care should be taken, when comparing the two sides of the chest, to percuss in symmetric regions. Thus the plexímeter finger should not rest upon one side over a rib and upon the other in an interspace; if so, a difference in the resonance will at once be recognized.

The percussion should be made upon the middle finger of the left hand, which should be *firmly* placed against the chest-wall. If due attention is not paid to this important feature, the resonance will be diminished appreciably in intensity, and in many cases will partake of a peculiar quality, to be later described as the "cracked-pot resonance." A slight lifting of any portion of the finger may be sufficient to produce this characteristic sound, therefore the plexímeter finger throughout its course should be firmly pressed against the thorax. The other fingers of the hand should be slightly raised from the surface of the chest, in order to avoid interference with the sound vibrations.

Nearly all authorities have directed that the particular part of the plexímeter finger upon which the blow should be dealt is the distal phalanx just back of the nail. This I have found to be decidedly less desirable than the second phalanx, for several reasons. The bone is much thicker and broader in the second phalanx, and affords a better medium for transmitting the vibrations. Other things being equal, those physicians make the best examiners who have large fingers with thick bones. The greater amount of soft tissue on the dorsal aspect of the last phalanx affords a cushion for the reception of the blow, thereby diminishing materially the intensity of the resonance. The distal phalanx just behind the nail, which is invariably recommended, is more sensitive to repeated percussion blows than the dorsal aspect of the second phalanx. My attention was first called to the disadvantage of the distal phalanx, because of the inflammation resulting from constant percussion upon this part, and recourse was had to the second phalanx, which was subsequently found to possess the advantages previously described.

The plexímeter finger should be applied with equal and uniform force when comparing the two sides of the chest. Unless this precaution is observed, striking differences in resonance will often fail of recognition. In examining at the apices, particularly with the patient standing, it is sometimes difficult to adapt the plexímeter finger to the fossæ above the clavicles in case of emaciation or marked apical retraction. In such cases the plexímeter finger of the left hand should be applied to the left apex, with the examiner in front. In this position there is usually no difficulty in adapting the plexímeter finger to the left side, while considerable trouble is experienced in applying the finger to the right apex of the patient. Under these circumstances, when percussing the right apex, it has been my custom to stand behind and to the right of the patient. Percussion should proceed along perfectly straight lines, as, if practised at random over the thorax, it avails nothing. In searching for the percussion boundaries of certain organs it is necessary to proceed *toward* the

known anatomic border in a line at right angles with it. It is also of advantage in some cases to keep the pleximeter finger parallel to the border which it is desired to outline.

The Manner in which the Blow is Dealt.—Comparatively little attention is paid by the average practitioner to this feature of percussion, and it is largely for this reason that incorrect results are so often obtained. The principle to be observed in dealing the blow is to deliver it quickly, the fingers instantly rebounding like the hammer upon the pianoforte when the keys are struck. The blow should be repeated three or four times in quick succession. The slightest lingering of the hammer finger upon the pleximeter finger is sufficient to interfere materially

Fig. 28.—Showing wrong method of percussion.

Fig. 29.—Showing correct method of percussion.

with sound vibrations, and thus modify the resonance. As sometimes practised, the hammer finger or fingers are allowed to remain upon the pleximeter finger while the examiner listens to ascertain the characteristics of the resonance. It is much better that the middle finger of the right hand should serve as the hammer and not permit the other fingers to be in contact with it. The blow should be dealt with the bulbous tip, this portion striking the pleximeter finger always at a right angle. It is imperative that a uniform amount of force be used in delivering the blow, as slight variations may result in failure to bring out striking differences of percussion. One of the most important considerations pertaining to percussion relates to the region from which the hammer motion is made. All writers who have mentioned this subject have

laid stress upon the fact that the blow should be directed entirely from the wrist-joint and never from the elbow. In so far as relates to the avoidance of any elbow movement this contention is, of course, correct. It is also true that there must necessarily be some motion, no matter how slight, from the wrist-joint, but the point is made that for successful percussion the best results are obtained by a gentle tap emanating very largely from the carpophalangeal articulation. In Figs. 28 and 29 will be noted respectively the incorrect and the proper method of percussion.

The relative merits of light and heavy percussion many times have been discussed. There can be no difference of opinion that, save under very exceptional circumstances, gentle percussion is far more satisfactory. This being so, there seems to be little occasion for dealing the blow from the wrist. This usually results in lifting the finger and hand as a single piece of mechanism farther from the chest than is necessary to bring out clear vibratory resonance. In most instances a gentle tap, raising the hammer finger not over one to two inches from the plexímeter finger, will suffice.

The Position of the Examiner.—Percussion should not be attempted unless the physician is perfectly comfortable, otherwise attention is almost unconsciously distracted from his work. When comparing the two sides of the chest, he should stand either directly in front of or behind the patient, in order that the sound may proceed to him from equally distant points. He should not attempt to percuss while bending over the patient, as the resulting rush of blood to the head interferes to some extent with the sense of hearing. He should endeavor, as far as possible, to maintain the same relative position with reference to the patient when percussing various parts of the chest. If the patient is standing, the examiner may stand also, care being taken, however, to lower his own body when examining the bases, particularly if the patient is short. If very tall, however, the patient should sit while the physician examines the apices and upper portions of the chest. Often he may be able to examine the lower portions of the thorax with ease if the patient is standing. If the person examined be very short, the physician should so lower the body that his hands may be applied with ease to the part examined.

PERCUSSION OF THE NORMAL CHEST

There is no fixed or arbitrary type of percussion resonance for the normal chest. Each person necessarily has to furnish his own standard, and it is only by a comparison of corresponding parts of the chest that deviations from the normal can be ascertained.

Regional differences are noted in intensity, pitch, and quality.

The supraclavicular region exhibits less intensity of resonance than many other parts of the chest, as there is less volume of lung beneath the part percussed. A diminution of vesicular quality is often pronounced near the inner or sternal aspect of the lung, on account of proximity to the trachea, which contains a relatively large volume of air. As the vesicular quality diminishes and the tympanitic element becomes more defined, the pitch correspondingly rises. The characteristics of apex resonance are lessened intensity, slight admixture of the tympanitic with the vesicular quality, and a somewhat higher pitch.

Similar changes are recognized upon percussion of the clavicle itself. The intensity is much weaker at its outer or acromial end, while the quality is relatively more tympanitic and the pitch higher at its sternal end.

In the infraclavicular region, extending from the clavicle to the third rib, the intensity is usually greater than in any other part of the chest, the quality distinctly vesicular, and the pitch low. It is possible in some instances to recognize, however, a very slight tympanitic element, with a little elevation of the pitch, in the upper sternal region from nearness to the primary bronchi. The characteristics of normal resonance are identical upon the two sides of the chest in this region, as contrasted with the striking differences displayed below the third ribs. The presence of the underlying right auricle to the right of the sternum does not give rise to any differences in percussion resonance because of the overlapping lung.

The right and left mammary regions must be considered separately on account of essential differences between the two sides. Upon the right, the resonance is diminished in intensity on account of the thicker pectoral muscles in the male and the presence of the mammary gland in the female. The quality is purely vesicular, and the pitch low. The intensity is further lessened from the level of the fifth rib to the base of the lung, by reason of the underlying liver. This organ rises to the fourth interspace, and in the mammary line is covered by lung to the sixth rib. The diminished resonance, however, does not correspond with its upper border, the area of hepatic dulness not extending higher than the fifth rib in the mammary line. This is explained by the fact that the volume of lung covering the liver from the fourth to the fifth ribs is sufficient to conceal effectually the percussion evidences of the deep-lying non-aërated organ.

In the left mammary region the resonance is modified by the presence of the heart. In this locality a portion of the heart lies directly beneath the chest-wall. The apex is concealed by a thin, tongue-like projection of lung of insufficient volume to permit vesicular resonance. The upper portion of the heart upon the left side is covered with a layer of lung, giving rise to percussion resonance. Along the thin edge of the overlapping lung the resonance presents differences from the normal in pitch, quality, and intensity, by virtue of which deviations an area of cardiac dulness is recognized. Over the portion of heart in immediate contact with the chest-wall there is entire absence of resonance, this region being known as the area of cardiac flatness. The boundaries of the areas of cardiac dulness and flatness will be given presently.

The resonance elicited upon percussion over the very upper portion of the sternum is slightly tympanitic in quality, owing to the proximity of the trachea.

Much confusion exists in the minds of students and many practitioners as to the normal resonance over the sternum, especially from the second to the sixth ribs. This is one of the most important regions of the whole chest, and should always be the first locality explored upon percussion.

Underneath the sternum, between the second and fourth ribs, the anterior borders of the pleura of the right and left sides lie immediately adjacent to each other. While the right pleura descends almost vertically to the attachment of the sixth rib, the left leaves the sternum

at the lower edge of the fourth rib and travels obliquely outward and downward across the chest. The anterior border of the left lung also recedes outwardly from the sternum opposite the fourth rib, and descends obliquely outward and downward. The anterior border of the left lung also recedes outwardly from the sternum opposite the fourth rib, and descends abruptly to a point near the anatomic apex of the heart, where it sweeps forward and downward to cover the apex, *i. e.*, the so-called lingula pulmonalis. A portion of heart denuded of lung and pleura lies in immediate apposition to the inner aspect of the sternum, between the fourth and sixth ribs. On the right side it is covered by the corresponding lung. The lower portion of the sternum overlaps the left lobe of the liver, and in some instances a portion of the stomach. In view of these anatomic relations it might be supposed that the resonance from the second to the fourth rib should be entirely different in character from that found over the lower portion of the sternum, and that a similar variation should exist upon percussion to the right and left of the median line from the third to the sixth rib. Imaginary differences in percussion resonance over the sternum have been described by different writers, but, as a matter of fact, there is only a very slight change in resonance between the second to the fourth rib and the fourth to the sixth. Generally speaking, there is absolutely no difference between the resonance to the right and left of the median line.

The sternum is an excellent conductor of sound, and transmits almost equally throughout its entire surface, as low as the sixth rib, the resonance derived from the underlying lungs. For practical purposes the resonance over the sternum should be regarded as uniform from the second to the sixth rib. Dulness from the fourth to the sixth rib must be construed as evidence of such underlying pathologic conditions as pericardial effusion, displacement, hypertrophy or dilatation of the heart, just as dulness in the upper portion is suggestive of aneurysm, a possible distention of veins from valvular disease, and other causes.

An area in the left anterior lateral region, along the lower margin of the ribs, is known as *Traube's semilunar space*. This is bounded above by the lower border of the lungs, below by the colon, on the left by the spleen, and on the right by the left lobe of the liver. Percussion in this region may show a tympanitic quality, with corresponding elevation of pitch, thought to be transmitted from a more or less distended stomach or colon.

In the lateral regions of the chest the percussion resonance is usually intense—more so than in any other portion save the infraclavicular. The quality is vesicular, and the pitch relatively low. In the back the percussion changes at the apex are not especially different from those in front, the variations in pitch and quality being recognized more readily near the spine.

In the interscapular spaces the intensity is somewhat diminished, on account of the thickness of the deep muscles of the back; the pitch is slightly raised, and the quality less distinctly vesicular by reason of the closeness of the trachea and large bronchi. Percussion resonance over the scapulæ is relatively dull because of the thickness of the wing-like expanse of bone and soft parts. In the infrascapular region, on account of the thickness of the soft parts, there is recognized a

diminution of intensity sometimes necessitating the use of heavy percussion.

In minutely comparing corresponding portions of the chest it should be borne in mind that at the apices, front and back, and in the upper interscapular regions, there exists a normal disparity between the two sides, the right being slightly higher in pitch, less vesicular in quality, and with diminished intensity.

Percussion Boundaries.—In describing the percussion outlines of the lung it must be understood that there is not always an exact correspondence between the anatomic borders and the resonant boundaries. The upper limit of percussion resonance is about an inch and a half above the level of the clavicle, although some little variation may exist in different individuals. The practical consideration as to the height of the lung in any case relates chiefly to the amount of unilateral contraction, suggesting an existing or a preëxisting tuberculous process. The lower border of the lung upon the right side in the parasternal line is at the fifth rib; in the mammary line, at the sixth, and in the axillary, at the seventh. The inferior border of the lung behind is at the level of the eleventh rib at the vertebral column. In these localities pulmonary resonance ceases, the liver flatness usually affording a sharp line of percussion demarcation between the two organs. As previously stated, however, the line of hepatic dulness begins one rib higher than the upper border of hepatic flatness. In this area the volume of lung is not large enough to produce the ordinary type of normal vesicular resonance.

The change in the lower border of resonance upon inspiration and expiration is called the *active mobility* of the lungs.

Upon expiration the lung does not meet the attachment of the pleura. Upon full inspiration, however, it descends to this point, completely filling the space formerly occupied by the diaphragm and costal borders. With returning expiration the diaphragm rises and the sides of the chest-wall retract, obliterating the so-called "complemental space" of Gerhardt. Opportunity is thus afforded for striking differences in the lower percussion boundaries of the lung.

A difference in the inferior border is also noticed upon change in the position of the individual. This is called the *passive mobility* of the lungs. It has been found that the lower border is somewhat lower with the patient reclining than when standing, and in like manner the right lung depressed when he is upon the left side. While not of very especial importance, these facts should be borne in mind when an examination is made with the patient in these positions. It should be remembered also that whenever the volume of the lung has been notably increased from emphysema, the inferior borders will be appreciably lowered.

The Area of Cardiac Dulness.—The upper border of this region is the lower edge of the third rib, from its attachment to the sternum outward nearly to the mammary line, where it descends almost vertically to form the left border, passing through or just inside the nipple. The right boundary is the left edge of the sternum. As to its boundary, however, authorities differ within wide limits, some placing the right border of percussion dulness at about one centimeter to the right of the left edge of the sternum, and others even at its right margin. While it is admitted that in some cases, particularly in children, very careful

percussion will elicit appreciable dulness beyond the left margin of the sternum, it is, nevertheless, true that for practical purposes in adult life, the right boundary of cardiac dulness may be assumed to be the left edge of the sternum. The lower boundary cannot be outlined on account of the immediate proximity of the left lobe of the liver.

Fig. 30.—Areas of normal cardiac dulness and flatness in adults.

The area of cardiac flatness has for its right border the left edge of the sternum, precisely as the area of cardiac dulness. Its upper border is along the fourth rib, from its attachment to the sternum outwardly to a point about one inch inside the mammary line. From this it descends vertically and ends in the left lobe of the liver, as does the corresponding boundary of the area of cardiac dulness. The two areas are of irregular quadrangular shape.

As the small projection of lung covering the apex of the heart is not of sufficient thickness to yield percussion resonance, these areas of cardiac dulness and flatness offer a striking illustration of the dissimilarity between anatomic conditions and percussion boundaries. Allowance should be made for variations at different times of life. In children both the areas of dulness and flatness are much larger than in adults, the flatness in some instances extending as high as the third rib, and to the left, well beyond the nipple, and sometimes even to the right of the sternum. In old age the percussion regions are relatively small in size, the upper border of flatness sometimes being as low as the fifth rib. The areas of flatness and dulness, like the lower border of the lung, are subject to considerable differences in size as a result of the active mobility of the lungs. In the same way marked emphysema may diminish the areas sufficiently even to cause their complete obliteration.

PERCUSSION IN THE MIDST OF ABNORMAL STATES

It must not be supposed that percussion in itself is sufficient for the accurate diagnosis of diseased conditions. It simply affords the examiner more or less exact information with reference to the increase or diminution of the air-content. The knowledge derived from per-

cussion in association with the history and rational signs, together with recourse to other methods of examination, is sufficient to establish in most instances a positive diagnosis.

The recognition of percussion signs relates to the presence or absence of resonance, changes in intensity, changes in quality, and changes in pitch.

It has been stated that the standard of percussion resonance of one person rarely corresponds to that of another, and that the character of the resonance in some portions of the chest varies materially from that obtained in other localities. Thus a percussion resonance may be recognized as *normal* for particular regions, while the same resonance elicited in a different portion of the chest would be regarded as a distinct *deviation* from the normal. In searching for the physical evidences of morbid conditions, the regional differences of percussion should constantly be borne in mind.

It has been stated that percussion resonance is analyzed with reference to intensity, pitch, and quality, and that the normal resonance of the lungs in general is variable in intensity, low in pitch, and purely vesicular in quality. Duration may hardly be regarded as of sufficient importance to require more than passing mention in this connection.

Complete Absence of Percussion Resonance or Flatness.—There being no resonance, there can be no appreciation of intensity, pitch, or quality. The sound elicited is entirely devoid of these characteristics, and is precisely such as would be obtained in tapping over a solid body, as over the thigh or the arm.

For the production of total flatness certain pathologic conditions are necessary. Such changes may exist respectively within the pleural cavity, the lungs, or the bronchial tubes.

The presence of liquid within the pleural cavity, as in pleurisy with effusion, empyema, pneumopyothorax, or hydrothorax, may be sufficient to cause complete flatness upon percussion, but it does not follow that flatness will result in all cases. For example, in children with left-sided empyema a transmitted stomach resonance may replace the flat note incident to the purulent effusion. There may be complete flatness in some instances and only dulness or diminished resonance in others, according to the amount of liquid. If the size of a pleural effusion is small, flatness in most cases will be found in the lower portion of the chest, particularly in the back and in the lower axillæ. In extreme cases, however, this is often obtained upon percussion in the middle and upper portions. In pneumopyothorax, the liquid being entirely in the dependent portion of the chest, absolute flatness is found at the bases.

The conditions within the lungs sufficient to produce flatness are those which are accompanied by complete consolidation. This may occur as a result of pneumonia, pulmonary tuberculosis, the excessive compression of lung from accompanying pleural effusion, collapse or atelectasis of the lung, gangrene, pulmonary infarction of large size, or rarely new-growths arising from the pulmonary tissues.

Pneumonic solidification, according to its degree, may or may not be attended by entire flatness. Tuberculous consolidation is seldom so complete as to produce absolute flatness, although occasionally this is found to be the case. Compression of lung by pleural effusion is rarely sufficient to effect a complete disappearance of resonance. The

same is true of pulmonary infarctions, which are often so small in area as to escape detection upon physical examination. New-growths within the chest having the characteristics of a solid tumor, if situated superficially and of sufficient size, yield entire absence of resonance upon percussion. Gangrene of the lung may be so extensive as to give rise to flatness. The same is true of abscess of the lung and pulmonary cavities filled with liquid.

The part played by the finer bronchi in the production of flatness consists of the exudation incident to pneumonia, the extravasation of large quantities of blood accompanying pulmonary hemorrhages, and the transudation of serum into the finer tubes in cases of pulmonary edema. It is not maintained for a moment that the changes referable anatomically to the finer bronchi should be regarded as of general importance in the causation of flatness. These changes occur, however, incident to other conditions, and, therefore, are worthy of mention in this connection.

Changes in Intensity.—The intensity of the percussion resonance may be either increased or diminished. It is increased in children and in acute compensatory emphysema, on account of the increased tension of the pulmonary tissues.

In the latter instance the volume of the lung is greater, the stretching of the tissues of more recent duration, their elasticity as yet unimpaired, relaxation not having taken place, and increased resonance results, precisely as in children. Coincident with the exaggerated resonance there also are recognized slight changes in pitch and quality. The pitch is somewhat elevated and the quality less vesicular, or often tympanitic in character. In view of the fact that the important distinctive changes of the resonance in these conditions relate more particularly to differences in pitch and quality, the increased intensity must be regarded as of relatively minor importance.

Diminished intensity may exist whenever there is a greater relative amount of solid or liquid to air in a given portion of the chest. It may be occasioned by the same conditions, previously described, which, if present to a greater extent, would be sufficient to produce flatness. Aside from liquid within the pleural cavity, a diminished resonance may be effected by pleural thickening or by the presence of considerable exudate upon the pleural surface. Pulmonary changes responsible for dulness are partial consolidations, as in the early stage of pneumonia or after resolution has begun, tuberculous infiltrations, and compressions from pleural effusions, gangrene, infarction, etc. Moderate edema and extravasation of blood or other secretions into the smaller bronchial tubes may produce areas of dulness, particularly at the bases.

Diminished intensity is always associated with elevation of pitch and weakened vesicular quality.

Changes in Quality.—All resonance which is not vesicular must be regarded as tympanitic in quality. There are several varieties of non-vesicular resonance, conforming in general to the tympanitic type. These may be described as pure tympanitic resonance, amphoric resonance, and cracked-pot resonance.

Tympanitic Resonance.—This may occur in the presence of large cavities containing air, pneumothorax, pneumonic consolidation of the upper lobe, consolidation of the lateral portion of the left lung, compression of lung above the level of a pleural effusion, or long-standing cases of asthma and chronic pulmonary emphysema.

Tympanitic resonance is found but infrequently over pulmonary cavities. While some examiners by this means assume to recognize cavities of exceedingly small size, experienced clinicians, as a rule, do not hesitate to disclaim ability to detect them by percussion signs alone. It is believed by the best observers that tympanitic resonance, as a result of pulmonary excavation, can be elicited only when the cavity is located near the surface of the lung, and approximately the size of a man's fist. This form of resonance is found, however, amid a variety of conditions. In view of these facts it is easy to appreciate the relative unimportance of this sign in the diagnosis of pulmonary cavities.

Tympany is often obtained in pneumothorax, but on account of the anatomic changes the resonance, in many cases, more closely approaches the amphoric type.

During percussion over a pneumonic consolidation of the upper lobe a tympanitic note is sometimes elicited as a result of the transmission of vibrations from air contained in the trachea or primary bronchi. This is described as "William's tracheal tone." When such transmission does not take place, tympany is obtained in some instances over a partial pneumonic consolidation by virtue of the diminished tension of pulmonary tissues.

Tympanitic resonance may be elicited upon percussion of a localized area of consolidation in the immediate neighborhood of the stomach, the vibrations being conducted from the large air-containing organ.

In beginning tuberculous infiltration at the apex tympany is occasionally found, owing to the relaxation of the pulmonary structures.

The same cause also accounts for the tympanitic quality obtained upon percussion of lung compressed by pleural effusion. In vesicular emphysema the causal agent for the production of tympany is the relaxation of the pulmonary tissue, but the resonance is usually an admixture of the vesicular and the tympanitic types. In such cases the predominating tympanitic quality with accompanying elevation of pitch corresponds to the extent of the emphysematous condition.

Amphoric Resonance.—Contrary to the general teaching, this should not be regarded as a separate and distinct type. It is strictly a variety of tympanitic resonance, differing only to the extent that there is superadded a peculiar musical intonation. It is noteworthy that the similarity of the tympanitic and amphoric quality is supplemented by the fact that the two varieties of resonance may be observed in almost identical conditions. The musical quality may be imitated by tapping the cheek with the mouth open, the jaws more or less widely separated, and the muscles of the cheek drawn as tensely as possible. With the mouth open wide the pitch is relatively high, but it becomes low as the opening is made smaller. A suggestion of the sound is also obtained by gently tapping the outside of a jar, from which the name amphoric is derived. Inasmuch as a jar has a firm, unyielding wall with a smooth inner surface, air being admitted freely through an opening of variable size, it may be assumed that the pathologic change within the thorax likely to produce this form of resonance should represent an analogous condition. It is true that amphoric resonance may often be elicited over pulmonary cavities containing air and having free communication with a bronchial tube. For its production, however, it is also necessary that the cavity should be more or less regular in shape, of considerable size, and with smooth,

comparatively tense walls. As these physical conditions are seldom present in pulmonary excavation, it is of but little value as a cavity sign.

In open pneumothorax with collapsed lung a large body of air is contained within the pleural cavity, which opens into a bronchial tube. The surrounding wall is smooth, firm, and fairly regular in shape, and hence amphoric resonance is easily recognized. This is not always present, however, in pneumothorax, and there are other conditions in which it may be obtained. Occasionally it is observed upon percussion over compressed lung in cases of pleural effusion. This sign may be elicited, though not often, in the early stages of pneumonia, before consolidation has become complete. The chief distinguishing characteristic of amphoric resonance is simply a musical intonation added to a quality distinctly tympanitic.

Cracked-pot Resonance.—This form of resonance, like the amphoric, is tympanitic in character, and should not be regarded as a separate variety. Its tympanitic quality is so modified as to suggest the sound obtained by tapping a jar which is badly cracked. It is sometimes described as a chinking resonance, on account of a resemblance to the chinking of coin. It may be imitated by clasping the hands together loosely and tapping them against the knee, thus forcibly expelling the air. Although cracked-pot resonance is commonly supposed to be pathognomonic of pulmonary cavities, such is not always the case. This is occasionally recognized upon percussion over pulmonary cavities, but it is present as well in other conditions. It may be heard, like the amphoric, upon percussion of compressed lung accompanying pleural effusion, and sometimes in early stages of pneumonia. This sign is often noted during the percussion of young children, particularly if the lungs are overdistended from crying. A cracked-pot resonance is not infrequent in very thin-chested people, and is fairly common whenever the pleximeter finger throughout its entire length is not held firmly against the chest. A small layer of air between a portion of the finger and the wall of the thorax often produces the characteristic sound.

Changes in Pitch.—Allusion has been made to the changes of pitch incident to tympanitic resonance, which apply equally to the amphoric or cracked-pot varieties. The distinguishing characteristics of all deviations from the normal vesicular resonance relate not primarily to the change in pitch, but rather to differences of quality or intensity. There are, however, changes of pitch independent of essential differences of quality or intensity.

It is found, with the mouth of the patient open during percussion over relaxed pulmonary tissue, that the pitch is more elevated than when it is closed. This is readily appreciated by listening with the stethoscope while percussing, the bell of the instrument being held by the patient close to the open mouth. This change of pitch in the upper portion of the chest is found to apply to a tympanitic resonance arising from any cause.

Wintrich's change of pitch, as described above, has been supposed to obtain merely in the case of tympanitic resonance resulting from a pulmonary cavity, but the same phenomenon may be elicited upon careful examination, whatever may be the immediate cause of the tympany. By "Wintrich's interrupted change of pitch" is meant the

detection of an elevated pitch with the stethoscope before the open mouth when the patient is in a certain position, and failure to recognize the same deviation when another position is assumed. This sign must be regarded as strongly suggesting the existence of a cavity partially filled with liquid, the level of which varies according to the position of the patient.

Gerhardt's change of pitch relates to a difference obtained according to the position of the patient, without any reference to the opening or closing of the mouth. The physical condition necessary for its production is the presence of a cavity, oval in shape, partially filled with liquid. If the longitudinal diameter of the cavity corresponds with the vertical axis of the body, it will be seen that the column of air above the level of the liquid is much higher with the patient in the erect position than is the case when reclining. A distinct variation in pitch over a small circumscribed area, according to the position of the patient, presents strong percussion evidence of a pulmonary cavity.

Taken as a whole, however, the percussion signs of pulmonary cavities are exceedingly unreliable. As a matter of fact, they are recognized with ease upon auscultation when no percussion evidence of their existence can be detected. The several forms of resonance, exhibiting variations in pitch and quality, occasionally obtained upon percussion over cavities, constitute considerations of much interest, but rarely of definite pathognomonic value to the examiner.

CHAPTER XXXII

AUSCULTATION

Auscultation as applied to the lungs refers to the act of listening to the sounds produced by respiration, the voice, and *artificial cough*. There is no method of physical examination so confusing to students, if not to practitioners, as auscultation. An explanation is found not so much in the lack of facilities to acquire practical experience, as in failure to utilize the opportunities which are presented. This in turn is supplemented not infrequently by inadequate preliminary instruction relative to auscultation. The methods of teaching this branch in medical schools vary within wide limits, and a decided lack of uniformity is also exhibited in the manner in which the subject is treated in various text-books. Several entertain radically opposing views with reference to matters of classification or nomenclature, the analytic characteristics of some of the sounds produced, their interpretation, and association with other signs. It is not strange that students experience difficulty in securing an intelligent understanding of the subject, and that practitioners report a diversity of auscultatory findings. It is not the bedside teaching alone nor the clinical facilities offered in dispensaries, which, for this particular branch, should be regarded as of prime importance. The observation and study of abnormal conditions, rendered possible by excellent clinical advantages, are not so essential as preliminary instructions regarding normal conditions. It is com-

paratively easy for the student to recognize deviations from the normal when he has become thoroughly familiar with the sounds of respiration in health. Before beginning the examination of normal chests, however, he should be taught systematically the principles and arbitrary facts of auscultation. It is desirable that uniformity of method should be observed in the manner of imparting instruction, but it seems unavoidable that a diversity of teaching should arise as a result of the differing experience and opportunities of observers. In the description that is to follow no attempt will be made to conform to the expressed opinions of others further than has been established by personal experience. No teacher can assume the responsibility of describing what is not to him the actual result of his observation. An appreciative reference is here made to the most excellent work of Austin Flint, published more than twenty years ago, from which the author derived his early instruction concerning the principles of auscultation, and which, to some extent, has served as a guide for clinical observation and teaching. The only aim of these pages will be toward simplicity and clearness.

MANNER OF AUSCULTATION

Auscultation may be practised either with or without the aid of an instrument called the stethoscope. When this is not used, the examiner places his ear directly against the chest or some intervening fabric, as a towel or undergarment. Auscultation thus performed is called the direct or immediate method, and is employed more by older practitioners than by those who have graduated from medicine during the past quarter of a century. Some diagnosticians of experience continue to advocate the practice of direct auscultation, but the great majority of clinicians have discarded it save under exceptional conditions. Physicians unaccustomed to the continued use of the stethoscope are more certain of their auscultatory findings when employing the direct method, while students who are not experienced in direct auscultation often find considerable difficulty in appreciating physical signs which are perfectly easy of recognition with the stethoscope. The direct method does not possess any advantage of moment over the indirect. The claim sometimes made that it is of considerable value in enabling the examiner to recognize deep-seated conditions within the lungs is much less valid than formerly, on account of the comparatively recent introduction of a stethoscope peculiarly applicable for this purpose. Manifest disadvantages, however, attach to the direct method.

The first objection to its use is the fact that one cannot hear as plainly as with the stethoscope, provided both methods are practised to an equal extent.

In direct auscultation it is much more difficult to exclude extraneous sounds. Although the disturbing effect of noises in the room may be minimized by placing a finger in the other ear, a buzzing or humming is produced, obscuring in a measure the auscultatory sounds.

The employment of the direct method of auscultation predisposes to lax and superficial examinations. The sounds are conveyed to a degree through the clothing, and physicians in the midst of a busy practice fall into the unfortunate habit of conducting an examination without the denudation of the chest. Examinations thus made are

necessarily imperfect and afford ample opportunity for inaccurate conclusions.

Parts of the chest, notably the apical regions, on account of their anatomic configuration, are not susceptible of a thorough examination by the application of the ear.

It is impossible with this method to circumscribe definitely the area from which sounds are to be derived.

If the examination be conducted in a thorough manner with the chest bare of clothing, the direct method should be discountenanced for women on the score of propriety.

Among the ignorant and unclean the application of the ear to the skin is not agreeable to the examiner, and is often unsafe, through the danger of possible contagion from parasites.

These disadvantages of direct auscultation without any compensatory benefits would seem to constitute sufficient objection to its employment, save when the stethoscope is not available.

The stethoscopic method is found to remove all the foregoing objections. The respiratory sounds are clearer and more intense, greater concentration is afforded by the exclusion of noises from the street or within the room, and regions incapable of examination with the ear are readily accessible by means of the instrument. In addition, sounds are obtained over a definitely circumscribed area, superficial examinations are less likely to result, and embarrassment on the part of the patient or examiner is, to a great extent, avoided. Some objections to the use of the stethoscope have been suggested, but all are of comparatively minor importance and scarcely worthy of mention. This will be discussed under the rules for the performance of auscultation.

THE STETHOSCOPE

Many stethoscopes of varying degrees of merit have been introduced. Some are exceedingly good for general employment; others possess a peculiar adaptability for certain purposes, and a few are very inferior for any use whatever. There is so radical a difference in details of construction among numerous stethoscopes that it may be assumed if one affords an excellent transmission of sound, many of the others must be less desirable. If the sound is transmitted to the ear chiefly through the current of air within the tube, rather than through the solid parts of the instrument, it is hard to understand why there should exist such a lack of uniformity in the diameter of the air column. In some of the instruments the solid and flexible tubes are of minute size, while in others they are of much larger diameter.

As to the solid parts of the instrument, there is found a decided difference in the shape and size of the ear-pieces, in the degree and direction of the curve proximal to the binaural extremity, in the material composing the solid tubes irrespective of size, in the joints, and in the character and construction of the spring, in the thickness and length of the rubber tubing, and in the dimensions, form, and composition of the bell of the instrument. It is evident that some stethoscopes have been designed with a view to the conduction of respiratory sounds through the solid parts of the instrument rather than through the contained column of air. A few are found to increase the intensity of the sounds, but at the same time to impart a peculiarly metallic quality.

In the majority of cases intensity does not constitute an important analytic characteristic of auscultatory sounds, but differences in the quality and pitch are of supreme significance. Provided the sounds are of sufficient intensity to be clearly distinguishable, there is nothing to be

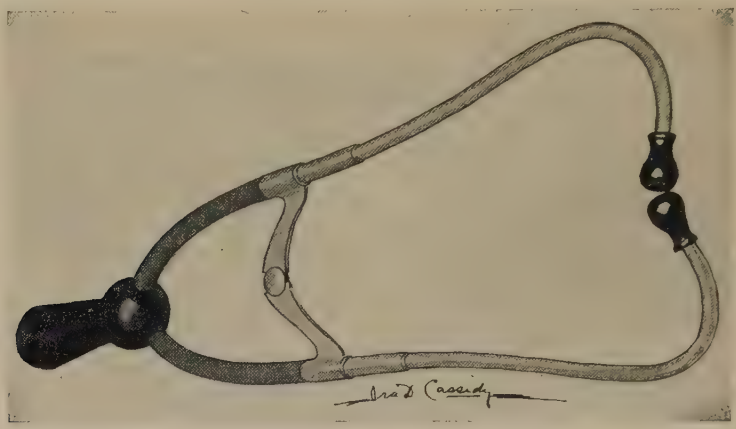


Fig. 31.—Foreshortened view of unjointed Camman instrument. Note large size of ear-pieces and moderate curve of the tube immediately adjacent, also the comparatively large size of the tubes, hard-rubber bell, and absence of metallic spring.

gained by the use of an instrument increasing intensity at the expense of differences in quality.

Such a stethoscope should be employed as will permit the conduction of the sound as little unchanged as possible to the ear. Physicians always obtain more satisfactory results when using an instrument to

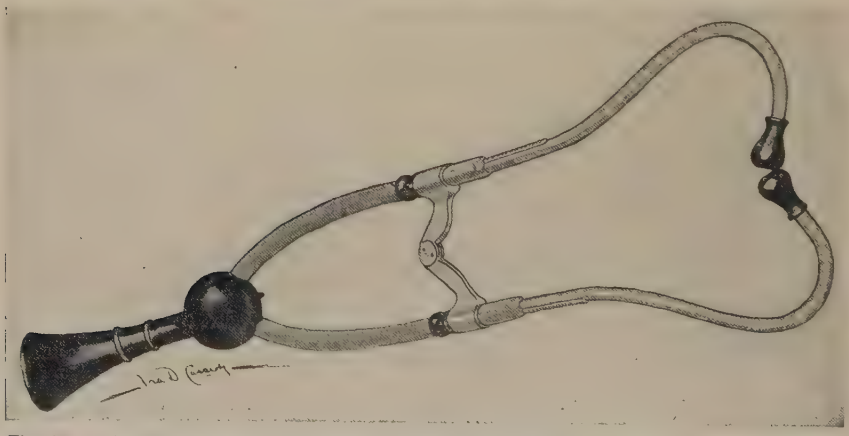


Fig. 32.—Jointed stethoscope with exaggerated curve adjacent to ear-pieces. Note the different shaped bell and the small projecting thumb point.

which they have been accustomed. Certain styles are adapted to some examiners, and especially contraindicated for others. It is as necessary to select the stethoscope with a view to its appropriateness for the examiner as his shoes, hat, or gloves. In choosing a stethoscope attention must be given to all the details of its construction.

Brief reference will be made to the most important parts of the instrument from the ear-pieces to the bell.

Care should be exercised not to permit the ear-pieces to extend too far into the external auditory canal. If so, a feeling of discomfort, if not of actual pain, is experienced, and the hearing becomes less acute. The ear-pieces should be of good size that they may not impinge too tightly into the meatus.

One of the most important considerations in selecting a stethoscope is the direction of the curve adjacent to the ear-pieces. Figs. 31, 32, 33, 34, and 35 illustrate the striking differences in this respect exhibited by several stethoscopes in extended use. In order to obtain the best results, the direction of the curve should correspond to the course of the external auditory canal, otherwise the aural aperture of the stethoscope

Fig. 33.—Illustrating still more exaggerated curve of the metallic tubes. Note steel spring and the size of metallic and soft-rubber tubes.

will be directed toward the cartilaginous portion of the canal and obstruct, to a vast extent, the sound transmission. It is obvious that if any one of the foregoing instruments is perfectly adapted to an individual, all the others must be quite inappropriate. The direction, as well as the extent, of the curve may be subject to enormous variation. While the student can often ascertain the suitability of an instrument by fitting several to the ear, it is of advantage to have an associate note carefully the shape of the ear and the direction of the meatus, in order to secure a better conformity of the stethoscope to the anatomic peculiarities of the individual. My own preference for general use are the stethoscopes shown in Figs. 33 and 34.

The solid tube should be of metallic construction, rather than of hard rubber, and its size should vary from four-sixteenths to five-sixteenths of an inch in diameter.

The spring of the instrument may be of steel, or consist merely of a rubber band. It is desirable that the spring should be sufficient to

force the ear-pieces comfortably within the meatus, therefore a variation in its strength is demanded for different individuals. There are

Fig. 34.—Representing still smaller metallic tubes and adjustable steel spring. Note diminished size of chest-piece.

two forms of adjustable steel springs, one of which should invariably be avoided. This is the thumb-screw, which is rather a clumsy contrivance, and precludes the removal of the stethoscope without turning

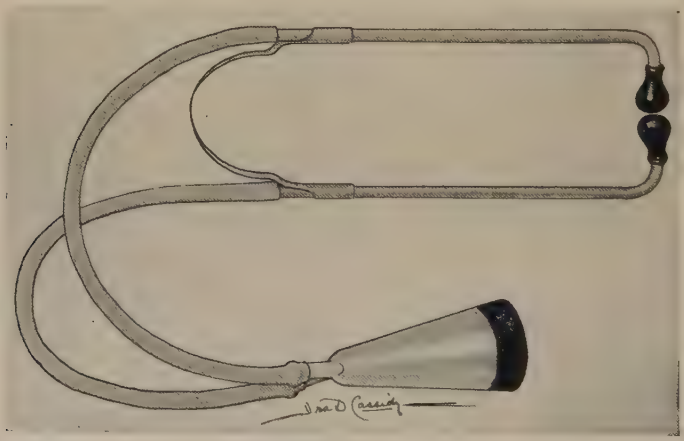


Fig. 35.—Representing a conspicuous difference in the shape and curve of the metallic tubes. Note adjustable spring.

the screw. Such a device is objectionable, for it prevents a continuous firm pressure of the ear-pieces within the external auditory canal. In another form of adjustable spring the attached arms slide up and

down the solid tube, producing a corresponding increase or diminution of the pressure. Objection has been made to the use of a rubber band lest the breath of the examiner induce vibrations leading to possible confusion, especially with beginners. The extraneous sound is of but slight import, and is present only when the rubber bands are so small in size as to permit easy vibration. The use of a thick rubber band is rarely attended by this trifling annoyance.

Jointed instruments possess no advantage and are objectionable, because of the frequent slipping of the parts.

The rubber tubes should be readily flexible in order to permit a quick and easy adaptation of the stethoscope to various parts of the body without a corresponding change in the position of the examiner. This is particularly important in the examination of infants or children. If the tubing is of small diameter and unduly pliable, it may collapse or kink at times and obstruct the sound transmission. If the tubes are too stiff and unyielding, they are less suitable for general use and are more likely to break when folded. Small apertures are often worn through the wall of the rubber tube from folding in the pocket. These openings frequently escape notice, and yet permit an appreciable diminution in the clearness and intensity of the sounds. The length of the tubes should not be over eight to ten inches.

The bell of the instrument may be of wood, hard rubber, or ivory. If there is any choice, wood seems to be preferable. At the present time it is difficult to obtain chest-pieces of this material. The inner opening of the chest-piece should correspond in size to the rubber tubing, while the distal extremity of the bell should have a diameter of about an inch and a half. Chest-pieces of slightly varying size may be used for different purposes, the small bell being particularly applicable to children.

Reference has previously been made to an instrument known as the Bowles stethoscope, which is especially adapted to the examination of deep-seated pulmonary conditions. One of its distinguishing characteristics is the shape of the chest-piece, which resembles a shallow cup with a diameter of about two and one-half inches. Across the cup extends a hard-rubber diaphragm, which may be covered, if desired, by thin rubber, to prevent slipping upon the skin. Although the breath-sounds are intensified somewhat, there is often an accompanying change in quality. No marked advantage attends the employment of this instrument, save in exceptional cases. It is sometimes a matter of convenience to examine under the shirt, but it is very seldom that a satisfactory examination cannot be made with an ordinary stethoscope. The method of dropping the chest-piece attached to a long tube down the back when listening over an invisible area is hardly in accord with the modern conception of clinical exactness. This instrument is quite unadapted to exploration of the apices or examination of greatly emaciated people, on account of the large diameter of the chest-piece. Another serious objection is the fact that the abrupt inward curve of the proximal extremities is unsuited to most individuals. The monaural stethoscopes are very little used in this country at the present time, and have no advantage over the binaural, while manifestly possessing many of the objections peculiar to the direct method.

RULES FOR THE PERFORMANCE OF AUSCULTATION

Intelligent auscultation demands the systematic observance of certain procedures on the part of the patient and the examiner. As far as the patient is concerned, the most important consideration relates to the manner of breathing. It is desirable that the patient should inspire rather forcefully in order to increase somewhat the intensity of breath-sounds and thus afford the examiner an opportunity to study other characteristics. Simply telling the patient how to breathe is not sufficient, as a rule. More satisfactory results are obtained by illustrating personally the desired manner of respiration. Difficulty is often experienced, particularly with nervous people, in securing a proper method of breathing during examination. Under these circumstances recourse should be taken to a single slight cough preceding inspiration. Patients should be instructed to breathe with the mouth slightly open and to avoid inhaling through the nostrils. They should be taught to take moderately quick, forcible breaths, and after a momentary pause to exhale completely, but without violence. This is rarely understood at first, unless demonstrated by the examiner. Some patients endeavor to inhale slowly and deeply in order to secure as full an inspiration as possible. Others are prone to give short, jerky inspirations, which are fully as undesirable. It is necessary that a complete expiration should be effected in order to permit subsequently a proper inspiration. Blowing or audible respiratory sounds should be avoided as much as possible. A moderately sharp inspiration, held momentarily, the patient exhaling without noise, offers the best opportunities for satisfactory auscultation.

The rules to be observed by the examiner are equally important and more a matter of detail.

A correct position of the physician is essential for the best results. The head, under all circumstances, should be erect, and the upper part of the body not too much inclined. Bending over the patient should be avoided in order to prevent the retention of blood in the head, which produces more or less discomfort and appreciably dulls the sense of hearing. Under all circumstances the examiner must be perfectly comfortable. If the patient is sitting, the physician should sit also, but when examining the lower portions of the chest, may rest upon one knee. When the patient is in bed, it is essential that the examiner should so adjust his position as to avoid the disadvantages incident to prolonged stooping.

The physician, when comparing opposite sides of the chest, should always *examine symmetric regions*. The various parts of the thorax should be explored in accordance with a systematic method, as opposed to the haphazard or roving auscultation so often observed. A diagnosis as to the physical conditions involving one side should not be reached without first comparing the sounds heard upon the other, no matter how conclusive the auscultatory evidences may appear.

The bell of the stethoscope should be pressed upon the chest-wall with a uniform degree of firmness, as distinct differences may fail of recognition through neglect to observe this precaution. The raising of a portion of the instrument from the chest-wall during a hasty or careless examination effectually prevents the conduction of intrathoracic sounds to the ear.

Especial care should be taken to avoid movement of the fingers upon the bell of the stethoscope when applied to the chest. It is surprising to what an extent a slight motion of the fingers may produce sounds obscuring the respiratory murmur or simulating râles. A fine raised point should project from the top of the bell, upon which the ball of the thumb may rest to hold the instrument in place, no other portion of the hand or fingers being in touch with the stethoscope. For some reason this small projection is not found upon many stethoscopes at the present time.

Very appreciable noises, sufficient to produce incorrect results, may be caused by the condition of the skin. Reference is made to the abundant growth of hair, the existence of scaly eruptions, and the extreme dryness of the skin in certain conditions. It would seem that these extraneous sounds, resembling dry or fine moist râles, might be avoided by increasing the pressure of the instrument against the skin and by using every precaution to avoid the slightest sliding movement. While such noises may often be excluded, the fact remains that in some instances they may be heard despite the observance of a rigid technic. My custom in such cases is either to rub a little vaselin upon the skin or to apply soap with a wet towel.

One of the most important desiderata for the examiner is to acquire, as far as possible, the *power of concentration.* He should listen to the intrathoracic sounds conducted through the stethoscope and be oblivious to all noises from without. This ability can be developed to a great extent even in the midst of much external confusion, although it is, of course, decidedly better if the examination can be conducted in quiet.

AUSCULTATION OF THE NORMAL CHEST

This includes listening to the sounds produced by the breath and by the voice.

Sounds Produced by the Breath.—Auscultation of the breath-sounds involves a minute comparison of inspiration with expiration, the general respiratory features being found to present striking differences. They are subject to analysis according to intensity, pitch, quality, and duration. It is essential to recognize thoroughly these four characteristics of inspiration, and to compare them with the intensity, pitch, quality, and duration of expiration.

There is a type of respiration called *"vesicular"* breathing which is heard over the normal chest. This presents differences in certain parts of the thorax precisely as regional percussion changes are observed. There is another distinct variety of respiration, known as bronchial or tubular breathing, which may be heard over the larynx or trachea in health. The peculiar characteristics noted are identical to the sounds produced in the chest in the midst of certain pathologic conditions. Inasmuch as all respiratory sounds conform more or less to one or the other of these types, and sometimes to both jointly, it has been found expedient to discriminate sharply between vesicular and bronchial breathing. It is usually better for the student to study the characteristics of bronchial breathing before those of the vesicular type. The fact that the respiratory sounds in the former are more intense, with sharply accentuated differences in pitch and duration, makes it somewhat easier for the beginner to compare the sounds of inspiration with those of expiration.

Bronchial Respiration.—With the stethoscope placed over the trachea or larynx the student at once recognizes an inspiratory sound, more or less intense, high in pitch, and of a quality which may be described as tubular, similar to that produced by blowing through a tube. The duration is somewhat less than the length of time consumed by the act of inspiration. In other words, the sound does not last until the very end of inspiration, the pause taking place just before the act is completed. The expiration is still more intense than the inspiration, of relatively higher pitch, of the same tubular quality, and much longer in duration. As the quality is the same in inspiration and expiration, the increased intensity, higher pitch, and prolonged expiration form the distinguishing characteristics of this type of respiration.

It is necessary that these auscultatory facts should be committed to memory. To this end a diagrammatic representation of the sounds in bronchial breathing is of some value in emphasizing the differences of inspiration and expiration. The method, as suggested by Dr. Garland, which I have employed for years, is shown below. The minus sign being associated with inspiration and the plus sign with expiration, enables the student more definitely to appreciate the sounds of bronchial breathing. A comparison of this with the diagram designed to illustrate the sounds of inspiration and expiration in vesicular breathing affords a simple way to impress these relations upon the beginner:

BRONCHIAL RESPIRATION

	Intensity.	Pitch.	Duration.	Quality.
Inspiration . . .	—	—	—	Tubular.
Expiration . . .	+	+	+	Tubular.

Vesicular Respiration.—The term "vesicular respiration" is applied to that type of breathing recognized upon auscultation of the normal chest. It is used to designate the breath-sounds reaching the ear of the auscultator through the final medium of the air-vesicles, just as bronchial respiration is applied to the sounds emanating from a bronchial tube or transmitted therefrom through consolidated lung. It must not be assumed that a strictly arbitrary or ideal type of vesicular respiration is applicable to all people, for each healthy person furnishes his own standard. Individual differences obtain with regard to the intensity of breath-sounds, referable to the age, the thickness of the muscles or overlying soft parts, and the manner of breathing. An analytic comparison, however, of inspiration and expiration discloses the fact that certain definite and unvarying relations obtain among all healthy persons.

Selecting as a suitable site for beginning auscultation the region below the right clavicle or in either axilla, the essential features of this type of breathing are easily recognized. The inspiration is of variable intensity, and the pitch is low as compared with that of inspiration during bronchial respiration. The quality, for the sake of convenience, may be stated to be vesicular, although described by some as breezy,

from its resemblance to the rustling of leaves agitated by the wind. The sound must be heard to be appreciated perfectly, and is best designated as vesicular, rather than by analogous terms. The duration of the sound during inspiration is as long as the act itself, there being no pause between inspiration and expiration unless the breath is voluntarily held by the patient.

In expiration the intensity is notably less than that of inspiration, and the pitch is likewise lower. The quality does not partake of the same breezy character of inspiration, and for lack of a better terminology may be regarded as blowing in type. The duration is much shorter than the *act* of expiration, and is less than the time consumed in inspiration. Without attempting a detailed explanation of the reasons why these differences exist between inspiration and expiration, it is sufficient to impress upon the beginner the fact that they actually occur. Le Fevre has admirably explained that in inspiration, which is an active function, the vibrations are conducted through the column of inspired air in the bronchial tubes to the air-vesicles, the sound being also transmitted by the ever-increasing tension of the bronchial and pulmonary tissues during the progress of inspiration. Expiration, on the other hand, is a passive motion, the direction of the air-current being away from the ear of the examiner, and the tension of the tissues constantly diminishing as expiration advances, thus minimizing the sound transmission.

VESICULAR RESPIRATION

	Intensity.	Pitch.	Duration.	Quality.
Inspiration . . .	+	+	+	Vesicular.
Expiration . . .	—	—	—	Blowing.

Some clinicians do not recognize essential differences in the quality of inspiration and expiration, and others describe the expiratory sounds as differing only in increased harshness. To my mind the quality of the expiratory sound differs somewhat from the inspiratory, but not in the way of greater harshness. The term appears to be an unfortunate one, for harshness often conveys to the mind an idea of increased intensity. This is diminished invariably in expiration, and for this reason, if for no other, it is better not to employ the word "harsh" to describe the quality of the expiratory sound. This may properly be applied to a certain modification of normal vesicular respiration, often designated as puerile breathing, which refers to increased intensity rather than to other essential deviations from the normal. Employing a diagrammatic illustration of vesicular respiration the plus mark, in contrast to bronchial breathing, will be found to denote the intensity, pitch, and duration of inspiration rather than of expiration.

Regional Differences.—The most important modification of vesicular respiration is observed at the apices. Upon examination of either lung at the apex the inspiration is recognized as less intense than below the clavicle, the pitch higher, the quality less vesicular, and in some cases the duration not quite so long. The expiratory sound in this region

is more intense than in the lower parts of the chest, the pitch higher, the quality a modification of the blowing and the tubular, and the duration somewhat prolonged. The change from the vesicular and the blending with the bronchial variety in some cases may be so pronounced as to justify the appellation "bronchovesicular respiration."

It is important to emphasize the fact that there is a normal disparity between the two apices, the modification of the vesicular type and the approach to the bronchial being more marked upon the right side than upon the left. At the right apex the inspiration is less intense than at the left, the pitch higher, and the quality less vesicular. The expiration is more intense, of higher pitch, and more prolonged upon the right side. This physiologic difference in the auscultatory signs at the two apices is a matter of the utmost importance, and should constantly be borne in mind in order to avoid possible mistakes in the diagnosis of incipient apical tuberculosis. A slight change, as described, at the right apex may not be possessed of any special diagnostic significance, while a diminished intensity, elevation of pitch, and diminished vesicular quality of inspiration, with a corresponding increase of intensity, still higher pitch, and prolongation of expiration upon the left side constitute positive evidence of a pathologic condition. Many patients have been sent to a distant clime on account of a supposed right apical tuberculosis, although upon examination there was found but an exaggeration of the physiologic disparity between the two sides, without even subjective evidence of tuberculous invasion. Some presenting unmistakable evidence of constitutional impairment have been sent away from home with a diagnosis of a tuberculous lesion at the right apex, yet the signs of active infection were confined to other regions. These inaccuracies sometimes occur for the reasons that physicians are in the habit of examining more carefully at the apices than in other places; that the normal difference between the two sides is often unappreciated; and that modifications of the normal breath-sounds are frequently recognized at the right apex, while in other parts adventitious sounds or râles are entirely overlooked because of neglect to utilize cough, which constitutes a valuable aid in auscultation. An appreciable retraction of the apex, with change in percussion resonance, is often of material aid in forming a correct conclusion. The recognition of moisture at one apex following a cough clears all doubt as to the presence or absence of abnormal conditions. In the axillary or infra-axillary region the intensity of the inspiration is quite as loud as below the clavicle, being greater in these two places than in any other part of the chest. The pitch, if anything, is lower than in the infraclavicular region, and the quality somewhat more vesicular. There is no difference between the two sides in this region.

Over the scapulæ the sounds of inspiration and expiration are less intense than in almost any other locality. Differences in pitch, quality, and duration are less easily recognized in this region because of the diminished intensity. There is no disparity to be recognized between the two sides.

In the interscapular spaces the intensity of the breath-sounds is nearly as great as in the infraclavicular or axillary regions. There exists a slight difference between the two sides, similar to the disparity noted at the apices, though less in degree.

Normal Voice-sounds.—In describing the sounds of respiration,

attention was directed to the types of breathing heard over the trachea and the chest. In the same manner the sound produced by the spoken voice should be studied with reference to its characteristics when heard over the trachea and over the normal chest.

Vocal Resonance over the Larynx or Trachea.—If the stethoscope is applied to the skin and the patient directed to say "ninety-nine," there is conveyed to the ear of the examiner a disagreeable sensation of shock or fremitus, associated with a distinct appreciation of concentration and nearness. The sound is sometimes intense, but this is subject to some variation. These essential features are analogous to the sound obtained over the chest in certain states of disease. A fuller description of the sound of the spoken voice, to which the term "bronchophony" is applied, will be reserved for subsequent pages.

Vocal Resonance over Normal Lung.—With the stethoscope placed firmly against the chest during phonation, the auscultator is enabled to distinguish a vibration, although receiving no impression of shock or fremitus. There is no suggestion of concentration or nearness, the sounds appearing diffused and as if coming from a distance rather than emanating directly under the stethoscope. The vibration is found to increase directly with the loudness and harshness of the spoken voice, the lesser thickness of the soft parts, and the firmer pressure of the instrument against the skin. Men afford much better illustrations of the vocal resonance than women. The resonance varies in different portions of the chest, it being more pronounced at the apices than elsewhere, and more upon the right side than upon the left.

The Whispered Voice.—The student should listen to this over the larynx and the normal chest, the sounds heard in the former location resembling closely those recognized in the presence of certain pathologic changes in the lung. It will be understood that, in whatever region auscultation is practised, the whispered voice can differ but little from the sound of expiration. As the only difference relates to intensity, but brief reference need be made to the characteristics of the whispered voice. Over the trachea the sound is shrill, high pitched, more or less intense, and tubular in quality, suggesting a current of air driven forcibly through a tube. Occasionally, while listening in this region, it is easy to recognize the words uttered by the patient. During auscultation of the normal chest it is often impossible to distinguish the sound of the whispered voice. If recognized at all, the pitch is low and the quality blowing. At most an impression is received of a faint, low-pitched, whispered sound, without ability to recognize what is said by the patient. The same regional differences regarding the whispered voice are found to exist as obtain with the spoken voice.

AUSCULTATION IN THE MIDST OF PATHOLOGIC CONDITIONS

The study of auscultation in disease should be conducted with reference to the breath-sounds and those of the spoken voice, both aloud and whispered. Auscultation of the breath-sounds includes two distinct considerations—pathologic modifications of the normal respiratory sounds, and adventitious sounds, commonly described as râles, which are never present in health, save in senile atelectasis.

Modifications of Normal Respiratory Sounds.—Just as the study of the breath-sounds in health involves analytic comparisons of

the intensity, pitch, quality, and duration of inspiration with expiration, so in the midst of morbid conditions the same form of procedure should be employed in order to detect deviations from the normal. Rather than attempt to classify the various abnormal types of breathing by the use of descriptive names, as "emphysematous breathing," "asthmatic breathing," "cog-wheel breathing," etc., which method is often employed, I will group the various pathologic modifications with reference to changes in intensity, pitch, quality, and duration. This would seem to be the more simple and natural method, and it is hoped will appeal to students in being easily understood.

Changes in Intensity.—This may be entirely absent, somewhat diminished, or perceptibly increased.

It should be understood that in many instances changes of intensity bear not the slightest relation to differences in pitch, quality, or duration. The sounds, however, may be so feeble and faint as to afford no opportunity for further study.

Entire absence of breath-sounds may result from the same causes which, if present to a less extent, merely suffice to produce a diminution of intensity. Complete suppression of the respiratory sounds may take place in pleurisy with effusion, closed pneumothorax, pneumopyothorax, pneumonic consolidation, entire occlusion of primary bronchi, either from aneurysm or mediastinal glands, in pulmonary edema, or the filling of air-vesicles with extravasated blood.

Diminution of Intensity of Respiratory Sounds.—The breath-sounds may be enfeebled by reason of changes acting upon the outer or inner walls of the bronchi, accumulations within the bronchi, pathologic conditions in the lung tissue, within the pleural cavity, or in the wall of the thorax, involvement of the nerves, and influences preventing the descent of the diaphragm.

The outer walls of the bronchi may be subject to compression from mediastinal glands, aneurysms, new-growths, or greatly dilated hearts.

The inner walls are affected by catarrhal conditions inducing a thickening of the mucous membrane or involving exudative processes sufficient partially to occlude the lumen.

An accumulation of thick tenacious mucopus may obstruct the caliber of the tube to such an extent as to diminish the intensity of the breath-sounds. The presence of blood or serous secretions within the finer tubes may produce a like result.

The most important change in the lung resulting in an enfeeblement of the respiratory sounds is the lessened elasticity of tissue taking place in long-standing emphysema. In early or so-called compensatory emphysema the tension of the pulmonary tissues is increased and the breath-sounds are correspondingly more intense, but as the emphysema becomes chronic, a reverse effect is noted. Through the loss of elasticity or retractile power the respiratory excursion is gradually diminished. Reduction of intensity forms one of the chief characteristics of the *emphysematous type of breathing*. With this there are associated definite changes in the duration, the inspiratory sound being shortened and the expiration prolonged. The shortening of inspiration takes place at the beginning of the inspiratory act rather than at the end, as is found in bronchial breathing. There are no changes recognized as regards pitch in this form of respiration, neither is the quality affected materially, although the vesicular character is somewhat less distinct.

There is another form of breathing, similar in many respects to the emphysematous variety, occurring in the course of asthma. This develops as a result of spasm of the muscular fibers encircling the bronchial tubes. Like emphysematous breathing, the inspiration is shortened at the beginning of the inspiratory act and the expiration is prolonged, but the intensity is usually greater than in the purely emphysematous type. There is recognized no change in pitch, and it is very difficult to appreciate changes in quality, as loud adventitious sounds usually obscure other elements. The râles occur both during inspiration and expiration, are dry in character, and are called either sibilant or sonorous, respectively, according as they are high or low in pitch. Diminution of respiratory sounds may also be occasioned by consolidation, either partial or complete, as in pneumonia, pulmonary tuberculosis, compression of lung from pleural effusion, new-growths, and hemorrhagic infarcts.

The changes within the pleural cavity capable of reducing the intensity of breath-sounds relate to the presence of liquid or air, as in pleural effusion, hydrothorax, pneumothorax, and pneumopyothorax. In pleurisy with but little effusion the liquid remains at the base of the pleural cavity, reducing slightly the intensity of the respiratory sounds in this region. As the effusion becomes more extensive it is molded around the lung, interposing between it and the chest-wall a layer of liquid through which the respiratory sounds must pass before reaching the ear of the examiner. In hydrothorax or dropsy of the pleural cavity the liquid remains at the dependent portion of the chest and obscures the breath-sounds in this locality. If air is present in the pleural cavity, the diminution of intensity is dependent to a great extent upon the existing type of pneumothorax. In the closed variety the breath-sounds are diminished or absent, but if there is a free opening into a bronchial tube, varying degrees of intensity are exhibited. Under such circumstances characteristic changes in quality, pitch, and duration are recognized, to be described later as constituting amphoric and cavernous respiration. Among other conditions involving the pleura, causing enfeeblement of respiratory sounds, are extensive pleuritic adhesions with marked fibrous tissue proliferation following long-standing chronic pleurisies.

An inflexible bony thorax and great thickness of the soft parts may also reduce the intensity of breath-sounds.

A like result is caused by unilateral paralysis of the muscles of respiration, or a severe intercostal neuralgia, retarding respiratory excursion.

Complete descent of the diaphragm may be prevented by partial paralysis of the diaphragm, the presence of extensive abdominal dropsy, severe peritonitis, and marked abdominal distention from pregnancy or new-growth.

Increased Intensity of Breath-sounds.—The respiratory sounds are more or less increased in children and in thin-chested adults. The exaggerated intensity is so constant in children as to suggest the appellation of "puerile respiration," which bears no relation, however, to pitch or quality. The sounds are notably intensified in compensatory or supplemental breathing, which occurs in one lung when a considerable area of pulmonary tissue in the other is effectually incapacitated. This may take place as a result of pneumonia, pneumothorax, pleurisy

with large effusion, or extensive fibroid change. Under such conditions the respiratory needs of the individual are supplied only by the compensatory activity of the unaffected lung. With increased tension of the pulmonary tissues and with wider respiratory excursions the intensity of the breath-sounds is necessarily increased.

Changes in Pitch and Quality.—Inasmuch as deviations from the normal pitch almost invariably accompany changes in quality, it is well to consider these jointly. Coincident with changes in pitch and quality there also occur certain variations of rhythm and duration. In the forms of respiration now to be described the changes in pitch and quality constitute the chief, though not the sole, distinguishing characteristics. Deviations from the normal in duration and rhythm will be discussed subsequently. Changes in pitch and quality are found in bronchial breathing, bronchovesicular breathing, cavernous breathing, amphoric breathing, and metamorphosing respiration.

Bronchial Respiration.—A description of bronchial breathing has been given on p. 200, in connection with the type of respiration heard during auscultation over the trachea or larynx in health. The characteristics of the breath-sounds in that location were said to be identical with those recognized in the thorax in certain states of disease. The pathologic condition capable of producing this type of breathing in the chest is consolidation of lung, although differing degrees of consolidation produce modified types of bronchial breathing. It is possible that the consolidation may be so extreme as to prevent, in exceptional cases, any appreciation of breath-sounds whatever, while in others it may be insufficient to produce the pure form of bronchial respiration. The consolidation commonly results from pneumonia, pulmonary tuberculosis, and compression of lung from extensive pleural effusion. It is well to emphasize the fact that the intensity of breath-sounds bears no absolute relation to the changes in pitch, quality, and duration. The respiration may be no less bronchial by virtue of the fact that the sound of both inspiration and expiration is enfeebled. The tubular quality of both, the high pitch of inspiration, and the still higher of expiration, the slight shortening of inspiration occurring at the end of the inspiratory act, and the marked prolongation of the expiration, with its relatively increased intensity, are the chief points to be borne in mind.

Bronchovesicular Respiration.—This form of breathing is described by some as a combination of a purely vesicular inspiration, with an expiration of bronchial type. In order to avoid unnecessary confusion, such designation should be restricted in its application to one of the varieties of metamorphosing respiration. It is better to regard bronchovesicular respiration as a combination of the vesicular and the bronchial varieties, both as regards inspiration and expiration, as was so admirably explained in 1856 by Flint, whose classic description has never been equaled.

The inspiration may be neither distinctly vesicular nor bronchial in quality. It is of variable intensity, of comparatively low pitch in proportion as the vesicular predominates over the bronchial character, and conversely of high pitch as the bronchial quality is more pronounced. The expiration approaches a tubular quality, with corresponding increase of intensity, prolongation of duration, and elevation of pitch. This form of breathing is neither purely vesicular nor bronchial, the two types being blended in such a manner as to render it impossible to

separate the distinctly bronchial from the clearly vesicular, either in inspiration or expiration. During auscultation at the apices in health, and particularly upon the right side, the respiratory sounds suggest a bronchial element, although partaking strongly of the characteristics of the vesicular type. In disease bronchovesicular respiration is occasioned by partial consolidation, either from pneumonia, compression of lung, or pulmonary tuberculosis. An excellent opportunity is afforded for the study of vesicular, bronchial, and bronchovesicular respirations by daily examinations of a case of fibrinous pneumonia. During the first few hours the respiration may remain vesicular in character. This is followed by bronchovesicular breathing for a short period, and in turn succeeded by the bronchial type, or in rare instances, by an entire absence of respiratory sounds. When resolution has become thoroughly established, the respiration gradually changes from the bronchial to the bronchovesicular variety, the former becoming less pronounced with each succeeding day, and the latter more clearly apparent. As convalescence continues the tubular quality is less easily recognized, the pitch being lower both in inspiration and in expiration.

Cavernous Breathing.—This form of breathing is described by many as a modification of bronchial respiration, and is pronounced by some to be identical with amphoric breathing. There does not seem to be any valid reason for classifying the cavernous with the amphoric, nor for regarding it as one of the varieties of bronchial breathing. Not only are the pathologic conditions responsible for the production of the bronchial and the cavernous varieties distinctly dissimilar, but the characteristics of the two types of respiration, although sometimes difficult of clear discrimination by the beginner, are sufficiently unlike to avoid erroneous conclusions by the practised observer. While there is a certain degree of similarity as to the physical conditions producing the cavernous and amphoric forms, there is at the same time sufficient difference in the dynamics of the sounds to create distinctive characteristics.

Cavernous respiration suggests the presence of a pulmonary cavity, but this physical sign is not always elicited when there is excavation. Generally speaking, the cavity must be of fairly large size and situated comparatively near the surface of the lung in order to permit the recognition of cavernous respiration. It is conceded that, for the ready detection of a pulmonary cavity by means of auscultation, its long diameter must approximate six centimeters in length. If the cavity is centrally located and surrounded by consolidated lung, the respiratory sounds may simulate to some extent bronchial breathing, the cavernous signs being obscured by the intervening consolidation. The physical conditions requisite for the production of cavernous breathing are the entrance of air into the pulmonary cavity with each inspiration, and its exit upon expiration. This predicates the fact that the walls of the cavity must be flaccid and yielding, and that communication be established with an unobstructed bronchus. The bronchial tube leading to a cavity frequently becomes occluded by a thick plug of mucus, in which event the characteristic sign is incapable of recognition. This accounts for the alternating presence or absence of cavernous respiration over the site of a cavity at different periods. In suspected cases, when the signs are not perfectly clear as to the existence of pulmonary excavation, the patient should be instructed to cough in an effort to dislodge any obstructing plug. It is often unwise, from a single examination, to

deny positively the existence of cavity. Not infrequently I have been unable to demonstrate the auscultatory signs of a pulmonary cavity, the existence of which had been shown upon a previous examination.

In cavernous breathing the intensity is variable and the quality blowing both during inspiration and expiration, being similar to that of expiration during vesicular breathing. The pitch is low during both respiratory acts, but is lower in expiration, and the duration is longer. The intensity is not an important consideration, the essential features being the invariable blowing quality, the lower pitch, and the longer duration of expiration. Cavernous breathing resembles the bronchial type in no respect save that the expiration is prolonged in each, but the higher pitch and tubular quality of the latter are distinguishing features. Cavernous breathing is similar to vesicular respiration in the low pitch of inspiration and the still lower of expiration. The blowing quality of the latter, however, is not present in vesicular inspiration. In the cavernous type the expiration is of much longer duration. A pulmonary cavity may exist in close proximity either to a consolidated area or to normal lung tissue. This may give rise to the possibility of such modifications of the pure cavernous type as to suggest a separate designation. The term "metamorphosing respiration" has been applied to an admixture of the cavernous with the vesicular, or the cavernous with the bronchial, or the vesicular with the bronchial types of breathing, but this seems to be an unfortunate misnomer as applied to these conditions. Metamorphosing respiration should be limited to the description of cases in which there is recognized an inspiration of one type and an expiration conforming distinctly to another. It is well, therefore, to designate cases in which the cavernous variety is combined more or less with the bronchial as "bronchocavernous" respiration, and those in which the cavernous and vesicular are blended as the "vesiculocavernous" breathing, in the same way as was derived the term "bronchovesicular."

Bronchocavernous breathing may occasionally be recognized when the cavity is situated in close proximity to an area of indurated lung. The vesiculocavernous breathing is sometimes obtained, though less often, when the cavity is surrounded by normal pulmonary tissue. In rare instances it is possible for genuine cavernous respiration to be heard in cases of pneumothorax, but usually the anatomic conditions materially modify the sound and give rise to the physical sign called amphoric respiration.

Amphoric Respiration.—For the production of this type of breathing it is essential that there exist a cavity of considerable size in the lung, or an open pneumothorax, the presence of firm, non-collapsing walls, and communication with an open bronchial tube. The characteristics of amphoric breathing are in many respects similar to those of cavernous respiration, the only point of difference being the musical quality, which is the distinguishing feature of the former. This peculiar intonation is produced by the vibrations in a resonant cavity, and may be imitated by blowing over the mouth of an empty bottle. A fairly good idea of the musical quality may also be obtained by blowing gently with the lips partly closed in the act of giving a low whistle, or by pronouncing "who" with the whispered voice.

Metamorphosing Respiration.—As has been stated, this term can be properly applied only to cases in which the inspiration of one type of

breathing is combined with an expiration conforming to an entirely different variety. A vesicular inspiration is sometimes found in conjunction with a bronchial expiration, a cavernous inspiration with a bronchial expiration, and a vesicular inspiration with a cavernous expiration. When auscultation is practised over normal lung in close proximity to a consolidated area, a vesicular inspiration may be combined with a bronchial expiration. By virtue of its greatly increased intensity the expiratory sound is conveyed to the ear from the area of consolidation. Auscultation over normal lung adjacent to a pulmonary cavity in the same way may disclose an inspiration of vesicular type and an expiration cavernous in character, because of the relative increase in length and the greater intensity of the expiratory note in cavernous breathing. In like manner auscultation over a cavity in the midst of consolidated lung may reveal the blowing quality of cavernous breathing upon inspiration, and a tubular quality transmitted from the adjoining consolidation during expiration. Another description of metamorphosing breathing is sometimes applied to the change following the dislodgment of an obstructing plug of mucus, thereby affording opportunity for the recognition of sounds emanating from a cavity into which the air did not previously enter.

Changes in Duration.—From what has been stated with reference to changes in intensity, pitch, and quality, it is apparent that these modifications of the normal breath-sounds constitute physical evidences of great importance in the diagnosis of disease. Statements have also been made concerning the coëxistent variations in the duration of respiratory sounds. Differences in duration cannot be regarded as distinct physical signs, but are invariably associated with changes in pitch and quality.

Shortening of Inspiration.—This occurs in two distinct types of breathing, which have been described. In bronchial respiration the shortening occurs at the end of the inspiratory act, but in emphysematous breathing at the beginning. In the former the pitch is high and the quality bronchial; in the latter the pitch is low and the quality faintly vesicular. If the inspiration is shortened, a determination of the type of respiration is sometimes possible from a study of the pitch and quality of the inspiratory sound alone. Valuable confirmatory evidence is afforded by study of the expiration, which in bronchial breathing is still higher pitched and of tubular quality, and in the emphysematous variety of lower pitch and vesicular in quality.

Prolongation of the Expiration.—This occurs in four types of breathing—the bronchial, emphysematous, cavernous, and amphoric. A recognition of the particular variety of respiration is obtained by reference to pitch and quality. In bronchial breathing the prolonged expiration is high pitched and tubular in quality; in the emphysematous form it is low pitched and faintly vesicular; in the cavernous type it is low pitched and blowing, while in the amphoric it is low pitched and musical. A fairly accurate estimate of the variety of respiration in the presence of prolonged expiration can be made from the pitch and quality of the expiration itself, without reference to the inspiration. In doubtful cases it is of vast service to note the difference of pitch in expiration and inspiration, the higher pitch with the tubular quality of expiration suggesting bronchial breathing, and the relative lowness of pitch with blowing quality denoting cavernous respiration.

Change in the Rhythm of Respiration.—In addition to changes in duration there is occasionally observed a variation of rhythm. This form of interrupted breathing is sometimes called "cog-wheel respiration," having a jerky, irregular inspiration. The impression is given that there is some mechanic hindrance to the free entrance of air to the alveoli, and during inspiration an effort is apparently made to overcome an obstruction to the passage of air through the finer tubes. Formerly more importance was attached to the presence of this physical sign than at present. Interrupted breathing may be recognized as either general or local. If general, but little significance need be attached to its recognition. In such cases it is due to imperfect acts of breathing, either from pain, as in pleurisy and intercostal neuralgia, or occurs in nervous people and in those especially fatigued. It is quite frequently observed in women who are more or less nervous and embarrassed at the time of examination.

When obtained over a localized area, it may be regarded as evidence of some obstruction in the finer bronchi, due, no doubt, to the thickened mucous membrane or to valve-like occlusion of the tubes from masses of secretion. This explains its not infrequent presence in cases of incipient apical tuberculosis with catarrhal bronchiolitis.

Râles.—Râles are distinguished from the foregoing modifications of normal auscultatory sounds in being entirely different from those produced in health. They are much easier of detection than the modifications of normal sounds, yet their presence is very frequently overlooked by reason of faulty technic. This is shown in failure to examine the entire chest and in neglect to utilize *cough immediately preceding a sharp inspiration.* While râles are often recognized upon easy respiration, those which are of the utmost importance in diagnosis are elicited in many instances only by the employment of cough. This is particularly true of early apical tuberculosis before the development of extensive tissue change. In innumerable cases a sufficiently positive diagnosis of pulmonary tuberculosis can be made by the detection of unilateral râles before the appearance of other physical signs and prior to expectoration.

There exists an unfortunate laxity of method in the classification of râles. This entails exceeding confusion and doubt in the minds of students as to the significance of various râles and their method of origin. Some authors classify râles according to dryness or moisture; others point out distinctive differences in their quality, pitch, or intensity, or make use of purely descriptive terms. The best plan seems to be a classification according to anatomic location, with qualifying descriptions with reference to moisture and dryness, and a final analysis according to size, quality, and time. I am well aware of the deficiencies and limitations of any system of nomenclature, and can claim no special originality for the method to be presented. It is the one, however, that, in teaching, I have followed for many years and have found to be more satisfactory than any other on the score of simplicity.

Râles may be divided according to their anatomic location as follows: the tracheal, bronchial, vesicular, cavernous, and pleural. These are subject to further classification according to moisture or dryness, size, quality, and time.

Tracheal Râles.—These may be either moist or dry. Moist tracheal râles are produced by the presence of liquid in the trachea through which the air passes with each respiratory act. They are heard both

on inspiration and on expiration, and occur more frequently in the moribund state, at which time they constitute what is commonly called the death-rattle. They are also found in states of coma in which the sensibility of the mucous membrane is so benumbed as to preclude an effort toward expulsion. Moist tracheal râles, both in children and adults, are sometimes heard even at a distance from the patient. This is particularly true in late stages of pneumonia, when the secretions accumulate in the trachea and give rise to loud bubbling sounds. It is not true that the existence of these râles necessarily presupposes the death of the individual. Prompt emesis in children very often suffices to remove the liquid in the bronchial tract to such an extent as to cause for a time the entire disappearance of tracheal râles. Recovery is not impossible even in adults, despite the ominous import of the death-rattle. In croupous pneumonia remarkable results are sometimes obtained even in the very midst of impending death through recourse to prompt and thorough venesection. It seems little short of miraculous to observe the wonderful improvement which immediately ensues in some cases following relief to the right heart and engorged pulmonary circulation.

The Dry Tracheal Râle.—This variety is not produced like the preceding, by the passage of air through liquid, but its origin is incident to conditions closing to a variable degree the lumen of the trachea or producing some deviation of contour. Dry râles emanating from the upper respiratory passages may result from affections of the glottis, as spasm or edema, and from the presence of an exudative process, as in diphtheria. They may also be produced by large masses of tenacious secretion adhering to the wall of the tube over which the air passes, the sounds having a more or less distinctive character. The existence of a tumor encroaching upon the lumen of the trachea for the same reason causes this type of râles. It is remarkable how an extremely small new-growth within the interior of the trachea may cause these adventitious sounds.

The dry râle is entirely devoid of the bubbling character of the moist variety, and may be described as whistling, squeaking, wheezing, or stridulous.

Moist Bronchial Râles.—These are produced by the passage of air through liquid in the bronchial tubes, and may be heard both in inspiration and in expiration. Appreciable differences are recognized in size according as the râle originates from a large, medium-sized, or small tube. The chief distinguishing characteristics of these râles are their bubbling character, their inequality over a given area, and the time of their occurrence, during both inspiration and expiration. They are sometimes inconstant. Differences as to pitch and intensity are not of special importance. When occurring without pronounced pathologic change in the pulmonary tissues, the intensity is not a noticeable feature; there is no elevation of pitch and no appreciation of quality other than as relates to their bubbling character. When recognized, however, in the presence of consolidated lung, the pitch is correspondingly elevated, the intensity increased, and the quality sometimes ringing or explosive. On account of these variations in quality, pitch, and intensity, according to the presence or absence of consolidation, some writers have described the moist bronchial râles occurring in normal lung tissue as "mucous" or "non-consonating" râles, and those heard in the midst of well-marked

consolidation as "resonant" or "consonating" râles. The *specific characters of râles, with reference to pitch, quality, and intensity, do not constitute practical data for the diagnosis of consolidated lung.* It appears unnecessary to suggest differences in the quality and pitch of râles as a means of diagnosing consolidated areas. Such recognition is much more simple and accurate by means of percussion and by modifications of the normal breath-sounds. The term "mucous râles" should be avoided, as often the presence of mucus does not result in the production of moist bubbling râles, inasmuch as the secretion is too consistent to permit the passage of air. These râles far more frequently are produced by pus, blood, or serum in the tubes than by mucus. It is to be regretted also that the word "subcrepitant" is used to describe "moist râles occurring in the very finest bronchial tubes." The derivation of this descriptive term is found in the fancied resemblance of exceedingly fine moist bronchial râles to those originating in the air-vesicles, and sometimes called "crepitant." The two varieties are alike in being very fine, but aside from this feature the points of difference are very distinct. The vesicular râles are dry, rather than moist, non-bubbling in character, equal in size, and occur for the most part at a certain specified time during the act of respiration. The use of the word "subcrepitant" as descriptive of the fine moist bronchial râle has led to endless confusion among clinicians. In the interests of exactitude it is far better to discontinue the employment of the words crepitant and subcrepitant, to limit the classification of moist bronchial râles to the coarse, medium-sized, and fine, and to describe râles arising from the air-vesicle as "vesicular." The latter may be further qualified, if desired, by using the word "dry" or "crackling."

Moist bronchial râles may be heard in the midst of any condition which induces the presence within the bronchial tubes of homogeneous liquid through which air can readily pass. In acute bronchitis affecting chiefly the large tubes these râles are frequently absent altogether, because of the scanty secretion. In acute bronchitis involving the finer tubes, and in chronic bronchitis in which the secretion is more purulent and thin, the râles are plainly recognized. They are heard in edema of the lungs as a result of the presence of serum in the bronchioles. These râles are also heard following pulmonary hemorrhage with the presence of free blood in the bronchi, and in the course of pneumonia after resolution has fairly begun. A most important condition disclosed by their presence is the unilateral catarrhal bronchiolitis incident to the early stage of pulmonary tuberculosis.

Dry Bronchial Râles.—These râles are essentially dry in character, and their quality more or less musical. They may be likened to whistling, wheezing, squeaking, or hissing noises, which are heard both upon inspiration and expiration, and usually in all parts of the chest. These sounds may be recognized at one location, only to disappear and return from time to time during the same examination. The dry bronchial râle is the only one concerning which differences of pitch are worthy of special note. Sounds originating in the finer tubes are of higher pitch and are called sibilant. These are more or less shrill, piping, hissing sounds. Those arising from the large-sized tubes are lower pitched, loud, and snoring in character, and are described as sonorous. The production of dry bronchial râles is due either to some temporary occlusion of the lumen of the bronchial tubes or to a constriction of the

wall from spasm of the muscular fibers. These râles are sometimes present in the course of bronchitis, even if unassociated with much secretion. The most typical illustration of their occurrence is found in bronchial asthma and chronic influenza.

The Vesicular Râle.—There has been for a long time a difference of opinion as to the manner of production of this râle, and in recent years as to the specific time of its development. Some observers have been led to regard the râle as entirely pleuritic in origin, and it is quite probable that this is sometimes the case. To determine, however, the precise manner of its production is not so important as to obtain a clear understanding of its characteristics. All conclusions as to the method of derivation are more or less matters of theory. Personally, I am somewhat slow to renounce the assumption that this râle is produced at the end of a forcible inspiration by the separation of opposing surfaces of alveoli which were previously agglutinated by gelatinous secretions. The important features of the vesicular râle are its *fineness*, its *invariable crackling or clicking character*, its *equality*, all râles being identical, and its occurrence at the very *end of inspiration*. It is often proclaimed that this râle is sometimes semimoist in character, and that it may be heard during expiration as well as inspiration. It is true that very fine "semi-dry" râles of a clicking character are occasionally heard with expiration, as well as with inspiration, but these mixed sounds should not be designated as corresponding to the pure type of vesicular râle. They should be styled fine, moist, semimoist, or indeterminate râles.

The vesicular râle has long been regarded as pathognomonic of a single pathologic condition, viz., consolidation of lung in the early stages of croupous pneumonia. At this time it is often called the crepitant râle, in contradistinction to the so-called returning crepitant râle which is recognized in the beginning of resolution. In the early stage of pneumonia the appellation should be the vesicular râle, and in the stage of resolution the fine moist bronchial râle.

It is not well to regard pneumonia as the only condition giving rise to the production of the vesicular râle. It is often heard in the lower lateral region and at the posterior bases in the later stages of typhoid fever, when the patient is turned to the side or supported in the sitting position. It may be recognized when the patient has been confined to the bed for prolonged periods from any cause, particularly if there is deficient respiration, and in atelectasis of the aged. Râles closely resembling the vesicular are heard in the course of incipient pulmonary tuberculosis before the secretions in the finer bronchioles are sufficient to induce bubbling sounds.

The Cavernous Râle.—This is produced by the presence of liquid in a medium-sized or large pulmonary cavity, through which the air passes upon respiration or with the act of coughing. It is distinctly gurgling in character, and is usually low pitched, although if the cavity is surrounded by indurated lung tissue, its pitch may be high. The impression is given to the examiner of large bubbles, not unlike those obtained when boiling water in a large test-tube or small flask.

The Pleural Râle.—The pleural râles may be divided into those having their origin upon the surface of the opposing layers of pleura and those produced by the presence of liquid within the pleural cavity.

A considerable variety of descriptive terms are ascribed to the former, which is accounted for by the diversity of existing pathologic conditions.

If the normal amount of serum in the pleural cavity sufficient to permit the surfaces of the pleura to glide noiselessly over each other is diminished to a material extent, there results a slight grazing or rubbing sound, as a result of the mere dryness of the pleural surface.

If the exudative process is of a plastic or mucilaginous nature, there may be produced a crackling sound as the opposing surfaces are approximated.

If the exudation is of a firm, rough, shaggy, and fibrinous nature, the sounds are correspondingly modified, and in some instances are of a leathery or squeaking character.

Generally speaking, pleural friction râles may be said to merge from a faint, scarcely perceptible, grazing sound to a creaking, crackling, or leathery rub. The friction-rub may be imitated by moving the finger of one hand against the palm of the other held close to the ear. Pressure of the stethoscope intensifies the sound, which appears to come from directly under the bell of the instrument.

Pleural friction-sounds may be heard in the absence of any pleuritic pain. They are usually recognized in the lower portion of the axilla, and are more or less interrupted, occurring principally during inspiration and cough. They may be heard in dry pleurisy or pneumonia, and not infrequently at the apex in early pulmonary tuberculosis.

Râles arising within the pleural cavity following perforation may be divided into succussion sounds and metallic tinkling.

Succussion Sounds.—Succussion râles refer to loud, splashy sounds recognized upon shaking the patient with the ear held to the chest. This physical sign is obtained only as a result of the presence of liquid and air within the pleural cavity. It is not found in pleurisy with effusion or hydrothorax. The upper level of the liquid always corresponds to a horizontal plane, there being no curved line of dulness or flatness, as in the case of pleural effusions. There is also a deviation of the upper level of flatness, corresponding to a change in the position of the patient, which is not true to an equal extent in pleurisy with effusion.

Metallic Tinkling.—This physical sign may be elicited in pneumothorax, and exceptionally in large pulmonary cavities partly filled with liquid and having a free opening into a bronchial tube. Metallic tinkling is by no means constant, even in pneumothorax. For its production it is necessary that there should be an open communication with a bronchus above the level of the liquid. It consists of a series of high-pitched silvery notes which may arise during respiration, coughing, or speaking. The sounds suggest drops of water gently falling upon the surface of liquid contained within a resonant cavity. They are not unlike the tinkle produced by tapping lightly the highest bars of a xylophone. There is also a resemblance to the striking of tiny bells at a distance.

Indeterminate Râles.—It is not practicable to devote especial attention to the study of these râles. For the sake of convenience it is sufficient to include under this heading all sounds not distinctly characteristic of the râles which have been described. They possess but very little actual importance to the student, and their detailed description would only result in unnecessary confusion.

MODIFICATIONS OF THE NORMAL SPOKEN AND WHISPERED VOICE IN DISEASE

The Spoken Voice.—This sound in health, or the so-called normal vocal resonance, has been described as a diffused, low-pitched vibration, lacking the concentration, shock, high pitch, and nearness of the sound heard when listening to the voice over the trachea or larynx. In the midst of various pathologic conditions the vocal resonance is subject to a variety of changes. Just as the modifications of the normal *respiratory* sounds were studied with reference to changes in intensity, pitch, and quality, so the modifications of the *spoken voice* should be analyzed in accordance with the same method.

Changes in Intensity.—This includes entire suppression or diminution and increased intensity of vocal resonance.

Suppression or Diminution of Vocal Resonance.—This may result from the interposition of a layer of liquid between the lung and the chest-wall, as in pleural effusion, the presence of a large body of air in the pleural cavity, as in pneumothorax, edema of the lung, a large cavity filled with liquid, obstruction of a primary bronchus from pressure of aneurysm or enlarged mediastinal gland, and rarely complete consolidation of lung in croupous pneumonia.

In pleurisy with effusion, hydrothorax, or pneumohydrothorax the diminished intensity of the vocal resonance constitutes a physical sign of great importance. In these conditions and in simple pneumothorax the voice-sounds are invariably transmitted with but feeble intensity. In pneumonia the vocal resonance is usually perceptibly increased, but the reverse may be true in some instances. In severe cases of pulmonary edema the intensity is lessened by the presence of serum in the air-vesicles and in the interstitial tissue of the lung. When the diminished voice-sounds are occasioned by the existence of a cavity filled with liquid, the signs are circumscribed in area. The enfeeblement of vocal resonance from compression of a bronchial tube from any cause affords a suggestion that the sounds are transmitted to the ear of the examiner through the medium of the column of air contained within the bronchial tubes, rather than through the bronchial or pulmonary tissues. Many times I have noted complete absence of vocal resonance throughout an entire side, as a result of aneurysm or an enlarged mediastinal gland.

Increased Vocal Resonance.—In calling attention to the increased intensity of the normal voice-sounds observed in certain morbid states, it is desired to emphasize the fact that no reference is made to accompanying changes in pitch or quality. In this connection the increased intensity of the sound may be due either to partial consolidation of the lung or to the presence of a pulmonary cavity.

It may be heard over lung partially consolidated from any cause, as pneumonia, pulmonary tuberculosis, or compression. In beginning consolidation the vocal resonance often remains low pitched and more or less diffused or distant, although increased in intensity. As the consolidation increases, definite changes in pitch and quality take place, *irrespective* of the intensity, which may even become diminished.

Increased vocal resonance may be heard over pulmonary cavities, particularly if superficial and opening into a bronchial tube. If the cavity is situated in the midst of comparatively normal lung tissue, the pitch is low and the only remarkable deviation from the normal

is the increased intensity. If surrounded by consolidated lung, the pitch becomes correspondingly elevated, the sound more concentrated, associated with greater shock, and apparently nearer to the ear. In the majority of instances auscultation of the spoken voice over the site of pulmonary cavities discloses other changes than mere increase of intensity, which characteristics will be described presently.

Changes in Pitch and Quality.—These include bronchophony, egophony, pectoriloquy, cavernous voice, and amphoric voice.

Bronchophony.—The characteristics of bronchophony are identical with the normal voice-sounds heard during auscultation over the trachea or larynx. They consist of high pitch, nearness, concentration, vibration, or shock. The impression of nearness to the ear or concentration is usually quite vivid, in contrast to the diffusion and distance received when listening over normal lung. The shock conveyed to the ear of the examiner is distinctly disagreeable, although the intensity is not always increased. The latter does not enter into the distinctive features of bronchophony. This sign is often heard over consolidated lung, and has the same significance as bronchial breathing, although bronchophony may be recognized with a lesser degree of consolidation than necessary for the production of bronchial breathing.

Egophony.—Egophony is a modification of bronchophony, produced by the presence of liquid intervening between compressed lung and the chest-wall, as in pleural effusion. Two important characteristics of egophony are its high pitch and its concentration. The sensation of concentration is opposed to the diffuseness of normal vocal resonance, but the nearness of bronchophony is replaced by an impression of distance. There is superadded to these features a certain tremulousness which has been described as analogous to the bleating of the goat, hence the derivation of the name. It is not always heard in cases of pleural effusion, but is often detected near the level of the liquid when the effusion is of but moderate size. It is sometimes present over consolidated lung, but does not constitute a sign of special moment.

Pectoriloquy.—This refers to the audible transmission to the examiner not only of the sound of the spoken voice, but also the words themselves. This sign may be elicited in the presence of consolidated lung, pulmonary cavities, and occasionally open pneumothorax. Pectoriloquy does not involve necessary changes in intensity, pitch, or quality, but usually partakes more or less of the bronchophonic characteristics peculiar to consolidated lung, and sometimes suggests the cavernous voice.

The Cavernous Voice.—This is not an important sign, and is worthy of only the merest mention. The cavernous voice is heard chiefly when pulmonary excavation has taken place in the midst of indurated lung tissue. The sound is more or less intensified, with a certain admixture of the bronchophonic element. While it does not possess the distinct high-pitched shock of bronchophony, it is materially different from the simple increase of intensity heard over cavities in the midst of normal lung tissue.

The Amphoric Voice.—The essential characteristic of this physical sign consists of its musical intonation, which is dependent upon the presence of a body of air within a resonant cavity. It is heard more frequently in pneumothorax than in any other condition, although it may be recognized occasionally over large pulmonary cavities with unyielding walls.

The Whispered Voice.—The normal whispered voice has been described as exceedingly faint, soft, and low pitched, corresponding to the sound of expiration in vesicular respiration. It seems unnecessary to enumerate in detail the modifications of the normal whispered resonance which take place in disease, in view of the fact that the changes are almost identical with those described with reference to the spoken voice. It is sufficient to repeat briefly that the whispered resonance may be studied with regard to changes of intensity, pitch, and quality. The intensity may be diminished or absent from the same causes which produce enfeeblement of the sound of the spoken voice, although the whispered resonance may be entirely absent when the spoken voice is readily appreciable. Even in health it is so feeble as scarcely to be heard, save over the regions of the primary bronchi.

The intensity may be increased from partial consolidation of lung or the presence of a pulmonary cavity. When due to slight pulmonary consolidation, not only is the intensity increased, but the pitch is more or less elevated and the quality slightly bronchial. The change in pitch and quality is due to the fact that the whispered voice is precisely identical with the sound of expiration, save for the increased intensity. This *increased transmission of the whispered voice* with associated *elevation of pitch* and *tubular quality* constitutes a *very valuable sign* in the examination of patients who are too feeble to breathe as desired, or who are afflicted with aphonia.

An increased intensity of the whispered voice is often appreciable before recognition of bronchial or bronchovesicular respiration is possible. When this is due to the presence of a cavity in the midst of comparatively normal lung tissue, the intensity is noticeably increased, but the pitch remains low and the quality slightly blowing, the sound being described as the cavernous whisper.

The high pitch and tubular quality of the whispered voice over thoroughly consolidated lung are sometimes described as the increased bronchial whisper, or whispering bronchophony.

Over a pulmonary cavity of considerable size, surrounded by indurated pulmonary tissue, the whispered voice partakes to a certain extent of the characteristics of whispering bronchophony.

Whispering pectoriloquy may be heard over the site of a pulmonary cavity, especially if superficially located, and also, though less often, over consolidated lung. The whispered resonance may assume a musical echo, and is spoken of as the whispered amphoric echo. Sometimes an appreciation of a distinctly musical intonation can be obtained more easily with the whispered resonance than with the spoken voice.

SECTION II

PHYSICAL SIGNS OF PULMONARY TUBERCULOSIS

CHAPTER XXXIII

GENERAL CONSIDERATIONS

THERE exists no conventional standard of physical signs common to all cases of pulmonary tuberculosis. The extent and character of physical evidences are so varied in different individuals as to preclude the conception of a definite type or combination of signs. Irrespective of the subjective symptoms, the former may be so slight as scarcely to be recognizable upon rigid examination, and, on the other hand, so numerous and complex as to represent a remarkable variety of morbid changes. Pulmonary tuberculosis with its complications may admit of every possible sign referable to intrathoracic disease in general. Some consumptives, on the other hand, present every external appearance of health and vigor, displaying either extensive destructive change or comparatively insignificant physical signs.

The range of possibilities as to what may be observed upon inspection, palpation, percussion, and auscultation is almost infinite. It is manifestly impracticable to attempt the description of any group of physical signs, or even of a single manifestation, which may be accepted to be of general application in consumption. Current medical literature upon the diagnosis of pulmonary tuberculosis is replete with classic descriptions of the various physical signs, which too frequently are grouped without expression as to their respective frequency or importance. Obviously, an arbitrary classification of signs without regard to their constancy or significance affords no proper accentuation of their comparative value. Failure to discriminate regarding their relative importance has led to much difficulty and delay among students and practitioners in establishing an early diagnosis of the disease. Many signs commonly regarded as characteristic of phthisis are singularly inconstant or devoid of definite interpretation, while others, actually pathognomonic in import, are elicited only upon correct methods of examination. It is essential, therefore, in portraying the physical signs of pulmonary tuberculosis, to depict certain features with especial clearness in the foreground, in order to afford a proper perspective. Signs of frequent occurrence and conspicuous significance should be contrasted prominently with those of minor importance and uncertain interpretation.

As a matter of fact, the physical evidences of early pulmonary phthisis do not refer essentially to slight deviations from the normal apical boundaries upon percussion, nor to doubtful modifications of the respiratory murmur. Several physical signs arising from a slight deposit of tubercle at one apex have been described by writers with infinite pains, but their practical value is often vastly subordinate to that of other objective manifestations, the importance of which is not always appreciated. It should be remembered that in *very* incipient phthisis gross pathologic change capable of detection by means of physical examination is comparatively infrequent, the area involved being of such minute size

and depth from the surface as to preclude recognition even by the most skilled examiners. Furthermore, the foci of infection are sometimes scattered to a considerable extent and separated from one another by intervening lung tissue, which is either of normal character or the subject of slight degrees of compensatory emphysema, rendering still more obscure the detection of finer structural change.

In applying to pulmonary tuberculosis the general principles of physical diagnosis enumerated in the preceding section, each sign will be considered separately, but an effort will be made to dwell at length only upon features of decided practical importance. It is believed that more of real interest and value will accrue to general practitioners from a review of the more common factors of supreme significance, than from the perusal of pages devoted purely to a recapitulation of the ultra-refined aspects of physical diagnosis. The latter are of exceptional occurrence, of difficult recognition, and sometimes of doubtful import. It is affirmed with emphasis that failure to detect the evidences of pulmonary tuberculosis is not occasioned, in the majority of instances, by an actual paucity of physical signs, nor by the non-recognition of obscure shades of differentiation between the two apices. As a general rule, delayed diagnosis results from utter neglect to take advantage of the exact information afforded by a few unilateral signs which are usually present and of supreme importance.

Nothing can be more erroneous than the popular notion pertaining to the general appearance of the consumptive and the exhibition of the so-called phthisical thorax. While many pulmonary invalids in advanced stages are extremely emaciated, with thin, pinched features, sallow complexion, flushed cheeks, bright eyes, lusterless hair, long thin necks, and a suggestive configuration of chest, this description far from represents an invariable characterization of the consumptive's external appearance. Such a clinical picture applies only to a comparatively small proportion of cases. Many phthisical patients display a perfectly normal type of chest, while the paralytic thorax is exhibited not infrequently by non-consumptives. The phthisical chest possesses less significance as regards predisposition to tuberculosis than was formerly supposed. It is characteristic of many individuals and families to present a thorax strictly conforming to this arbitrary type, without the slightest semblance to pulmonary infection or an appreciable impairment of physical strength and endurance.

Waiving a detailed reference to the possible changes observed upon inspection of consumptives in general, it is well, in the interests of clearness, to consider separately the physical signs of early cases—those with moderate involvement and those with far-advanced infection.

CHAPTER XXXIV

EARLY CASES

In view of a somewhat prevalent misconception regarding the relative value of the various physical signs, it may be asserted that comparatively slight importance attaches to inspection, palpation, or percussion

in very early cases. Under these conditions the tuberculous process is often extremely insignificant, and areas of consolidation are entirely absent. For this reason it is very unusual to note visual changes in the contour or movement of the affected part, palpation also failing in many instances to disclose a retardation or deficiency of the inspiratory expansion. Successful percussion of the two apices before the stage of infiltration is exceedingly difficult. At a later period the detection of small areas of consolidation by means of percussion alone, with an accurate determination of resonant borders, is an accomplishment to be acquired only through unceasing practice.

It can be assumed that whenever appreciable deviations from the normal are recognized upon inspection, palpation, and percussion, the infection has been of sufficient duration to preclude its classification under the head of incipiency. It may happen that these methods of examination are available for the recognition of long-standing tuberculous processes, but this presupposes an antecedent pulmonary infection involving a diminution of the air-content. The visual detection of localized change is possible only in cases in which ample opportunity has been afforded for fibroid contraction. This shrinkage at the apex is sometimes associated with other signs, suggesting a tuberculous involvement, yet a well-defined retraction indicates clearly the long-continued existence of the original infection.

True incipient cases are *recognized* almost solely through recourse to auscultation. The prominent auscultatory signs, as a rule, do not relate to changes in pitch, quality, rhythm, or intensity of the respiratory sounds, but consist of *fine crackling râles* heard chiefly at the *end* of *inspiration following a cough.* These adventitious sounds are heard as very fine moist bubbles or as semidry clicks, occurring at the very end of inspiration, and usually absent upon ordinary quiet respiration. While forced breathing without cough often fails to elicit their presence in very early cases, a slight cough followed by a moderately sharp inspiration permits their ready recognition. Care should be taken to prevent a too violent cough or unduly vigorous inspiratory effort lest the finer adventitious sounds be thus obscured. It is essential, however, that the act of inspiration be sufficiently pronounced to agitate the secretion in the finer bronchioles. A momentary pause following the cough and preceding the inspiration facilitates the detection of the râles. The inspiration should be taken with the mouth open, rather than through the nostrils. Confusion sometimes arises from hearing a momentary click, which disappears after the first two or three coughs, and is due to a partial atelectatic condition prior to the sharp inspirations. Persisting sharply localized unilateral râles may usually be regarded as pathognomonic of tuberculosis. It is generally believed that the especial significance of these râles with reference to tuberculous involvement relates to their recognition in one apex. While this is the more common site of their occurrence, it is, nevertheless, true that they may be found under the clavicle, in the axilla, and in the upper interscapular space, frequently opposite the spine of the scapula. Sometimes they may be detected in that portion of the lung overlapping the apex of the heart—the lingula pulmonalis. While the recognition of râles in this region may suggest the possibility of their pleural origin, an assumption as to a possible tuberculous invasion is justified to but a slightly less extent. In Fig. 36 is shown a small area of tuberculous

involvement in the right interscapular region. The signs consist solely of faint, scarcely recognizable clicks at the end of inspiration, following a cough. There are no physical evidences of infiltration, the pitch, quality, and rhythm being entirely normal. It is interesting to note the entire absence of signs at the apex. A striking confirmation of the physical findings was subsequently afforded by the *x*-ray picture shown in Fig. 49.

In emphasizing the vast importance of râles as a factor of early diagnosis, due cognizance is taken of the conflicting opinions entertained by other observers. Some regard a roughened breathing, variously termed "cog-wheel" or "harsh" respiration, as of paramount value in the early determination of tuberculous lesions. The descriptive appellation "harsh" should relate strictly to increased intensity. It is difficult to ascertain precisely what is meant if this is applied to changes of pitch or quality. If it be assumed that certain modifications of normal

Fig. 36.—Photograph of back, showing a small initial area of tuberculous involvement, with apex clear.

breath-sounds are recognized which are scarcely appropriate for classification under bronchovesicular respiration, it is affirmed, contrary opinion notwithstanding, that their significance is decidedly inferior to that of localized râles, which are so frequently overlooked. Cog-wheel or interrupted respiration unassociated with other signs has been described as of extremely doubtful value, although considerable importance has been attached to this sign in the past. Jerky respiration may be suggestive of a catarrhal involvement of the finer tubes, but when present at one apex, to the exclusion of the other, even without crackling râles, justly affords a strong suspicion of incipient tuberculosis. It is interesting, in reviewing charts presented by pulmonary invalids, to note the multiplicity of detail with reference to the finer shades of respiratory sounds in various parts of the chest, in connection with an amazing failure to recognize the distinct crackles upon cough. This frequent neglect to record the presence of râles in the apical regions obtains to an equal, if not greater, extent *beyond* the recognized *borders*

of tuberculous infection. Careful auscultation often fails to reveal the existence even of slight deviation from the normal respiratory sounds in such locations, while râles are easily elicited by the act of coughing. It is a source of considerable surprise to learn from observation that a large number of clinicians fail to take advantage of the assistance to be afforded by a gentle cough. A few are known to assert that râles are disclosed with greater ease and accuracy upon easy respiration. For general application such statements are illusory in the extreme, though occasionally a fine click may be detected after an initial cough, only to disappear subsequently upon the temporary dislodgment of secretion.

Save in the presence of tolerably well-defined areas of consolidation, important modifications of the normal respiratory sounds without râles are exceedingly rare in early cases. While noticeable infiltration of one apex may occasionally be found in the absence of râles, adventitious sounds are usually capable of recognition if proper means are taken to elicit their presence.

The most important unilateral modifications of normal respiratory sounds are the relative elevation of pitch, prolongation of expiration, and added element of tubular quality. The actual import of this approach to bronchial breathing depends largely upon a comparison of the respiratory sound at one apex with that obtained upon the opposite side. Thus the character of the respiration is of relative rather than of absolute value, and is of especial importance according to its location at the right or left apex. Attention has been called in previous chapters to the *normal disparity* between the two apices, particularly with reference to the elevation of pitch, the slightly tubular quality, and the prolongation of expiration upon the right side in health. It is thus impossible in some cases to determine with accuracy if slight modifications of the respiratory sounds upon this side do not occur as a simple exaggeration of the physiologic difference between the two apices. The significance of these signs, however, at the left apex is quite conclusive in denoting the existence of tuberculous infection. Equal importance may be attached to increased vocal resonance at the left apex, but its interpretation, if recognized upon the right side, is often illusory.

Some writers have attached considerable importance in early tuberculosis to the detection of impaired respiratory mobility upon one side, as shown by a diminished movement of the diaphragm. The descent of the diaphragm may be found to be incomplete unilaterally or simply retarded in time. As studied by the fluoroscope, the difference in time may be noted by comparing simultaneously the movement of the diaphragm upon the two sides. The extent of the diaphragmatic movement can be observed fairly accurately by using the method of Litten, described on p. 170, and marking the skin with ink and comparing the two sides, but this method affords no opportunity to note a unilateral retardation of movement. Generally speaking, a slight deviation from the normal descent of the diaphragm is more a matter of clinical interest than of practical diagnostic value in early tuberculosis, as this is often due to old pleuritic adhesions. An existing tuberculous infection sufficient to produce noticeable impairment or retardation of the diaphragmatic movements usually permits a ready diagnosis from physical exploration.

CHAPTER XXXV

CASES WITH MODERATE INVOLVEMENT

For present purposes a *moderate* tuberculous involvement of the lung may be defined as a partial non-extensive consolidation, with moisture in the bronchial tubes throughout the infected area. Cases of pulmonary tuberculosis belonging to this class do not display physical evidences of softening or excavation, as such signs are characteristic of more advanced infection. Manifestly, it is impossible to divide all cases of consumption into three arbitrary divisions. Many cases will be found extremely difficult of classification, because of the complex and divergent nature of the physical conditions. In the same individual there may be exhibited an area of incipient infection; in another region, a tuberculous process of distinctly moderate type; and elsewhere signs of cavity formation peculiar to far-advanced cases. A definition of the various types of pulmonary tuberculosis takes cognizance not only of the nature of the process and the extent of its distribution, but also the degree of its activity. Thus the physical findings may disclose a definite morbid change in the anatomy of the lung, either of small or large size, and yet suggest no existing activity of the tuberculous process. Obviously, such cases presenting corroborative subjective and bacteriologic evidences are not to be included in the classification of early, moderate, or advanced cases, but comprise strictly a class by themselves, to be designated "arrested cases." The *degree of activity may be measured* to a great extent *by the amount of moisture in the bronchial tubes.* In cases of moderate tuberculous infection the air-content in a given area is diminished by virtue of a partial consolidation of lung. As a direct result of the abnormality of tissue, distinctive changes are recognized in the physical signs.

Upon inspection there is rarely noted in individuals conforming strictly to this class a marked degree of emaciation, pallor, dyspnea, or cyanosis. There may be slight flushing of the cheeks, according to the extent of vasomotor disturbance, and moderate loss of weight, but the more important visual appearances are referable to the thorax proper. These changes are often sharply localized, and consist of unilateral deviations from the normal contour of the chest and of arrhythmic respiratory movements. Inasmuch as the tuberculous process usually elects the apex as its favorite site of invasion, the asymmetric conditions are observed more frequently in the upper portion of the chest. Conspicuous retraction of the supraclavicular fossa is often accompanied by flattening of the chest immediately below the clavicle. This stands out with greater prominence than its fellow of the opposite side, and the acromial end is appreciably elevated. The upper intercostal spaces may become accentuated from atrophy of the thoracic muscles upon the affected side, and a characteristic drooping of the shoulders may be noted, although less frequently than among cases with advanced infection. In addition to the altered configuration of the upper part of the thorax there may be observed localized impairment of respiration. In some cases this may consist of a diminished respiratory excursion, and in others of a retardation of the movement. While irregularity of contour is readily noted upon casual observation, a rigid comparative

scrutiny of the two sides is sometimes necessary to detect changes in the respiratory movement. They are recognized more easily if inspection be made with the examiner standing behind the patient and looking over the shoulders, to observe the simultaneous bilateral excursions. A distinct apex retraction is indicative of a long-standing lesion, while a mere retardation of movement without retraction suggests the existence of a recent infection.

Palpation may confirm the results of inspection with reference both to contour changes and to modifications of the normal respiratory act. It may be practised by laying the tips of the fingers in the supraclavicular fossa, with the thumb upon the vertebra, the patient in the sitting position, and the physician standing behind. In this manner differences in the inspiratory expansion at the apices are noted without difficulty. Information may be secured not only with respect to inequalities of respiratory excursion, but also as to the degree of consolidation, by virtue of the more ready transmission of voice-sounds through a partially solid medium. This is subject to considerable variation, as has been described in connection with vocal fremitus.

The percussion signs in cases of moderate tuberculous involvement relate to differences in quality and intensity and to the changed resonant boundaries. It must be remembered that each person furnishes his own standard of resonance, as has been described. As there is no ideal type of percussion resonance common to all individuals, deviations from the normal can be recognized only by a close comparison of the two sides. Attention is again called to the necessity of discriminating closely between the dulness and elevation of pitch upon the right and left sides respectively. Owing to the physiologic variation at the two apices a slight impairment of resonance at the right apex is of much less significance than at the left. The normal disparity is such that it is sometimes impossible, in case of right-sided dulness, to distinguish, upon percussion alone, between a possible exaggeration of the dissimilarity in health and a localized tuberculous infection. Dulness at the left apex, however, is highly significant of tuberculous change. Difficulty may arise in recognizing the dulness incident to small areas of tubercle deposit, owing to the vicarious emphysema of adjacent pulmonary tissue.

Deviations from the normal percussion outlines, while of great clinical interest in the more advanced cases, particularly if associated with extensive fibrosis, are not invariably pronounced in instances of moderate infection. In such the variations relate especially to the supraclavicular fossæ. In health the lung rises above each clavicle to a distance of about an inch and a half, differences between the two sides being rarely observed. An appreciable unilateral diminution of the height of the pulmonary resonance may be ascribed to the shrinkage incident to tuberculous infiltration and fibrosis. The lateral apical boundary is of importance, as well as the height of the resonant lung. This has been described at length by Krönig, Minor, and other clinicians. In many cases of unilateral disease the diminution of the resonant area is somewhat striking. While it is impossible to state with absolute accuracy that the shrinkage is of long standing, it is undoubtedly true that in the majority of instances the tuberculous process is of fairly remote rather than of recent origin. It is more a matter of clinical interest than of actual diagnostic value, for the reason that a tuberculous change in the apex sufficient to produce a well-defined variation from

the normal percussion outline must almost invariably be attended with auscultatory signs capable of ready recognition.

A pronounced disparity between the apical percussion boundaries upon the two sides may exist in the entire absence of tubercle deposit. Recently I have had occasion to note a conspicuous instance of apical shrinkage as determined upon percussion, which, without the aid of the *x*-ray, would have led to a deplorable error of diagnosis.

A man of twenty-five with an unfortunate family history of tuberculosis accompanied to Colorado, in the latter part of 1906, a sister in advanced phthisis. The patient speedily succumbed to the disease, and the survivor presented himself for examination and opinion before venturing to return permanently to an unfavorable climate. There were no symptoms suggestive of pulmonary involvement, and the physical examination was negative, save for a well-defined dissimilarity in the apical percussion boundaries. The extent of shrinkage at the right apex is shown in the accompanying photograph (Fig. 37). Upon *x*-ray

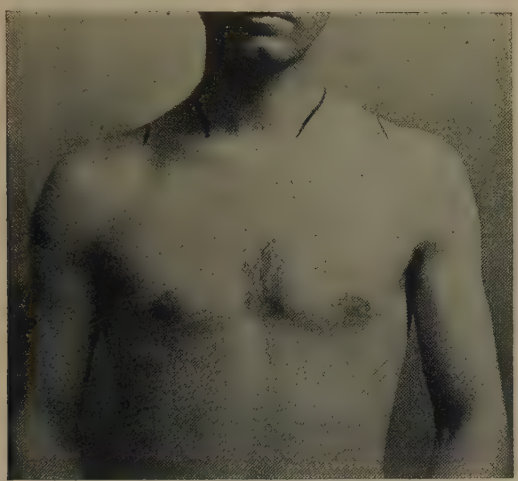


Fig. 37.—Disparity between the apical percussion outlines, suggesting a tuberculous involvement of the right apex, unconfirmed by *x*-ray examination. (See radiograph, Fig. 44.)

examination, however, it was found that a well-marked thickening of the right mediastinal pleura had taken place, resulting in pronounced traction upon the pulmonary tissues at the apex, without evidence of tubercle deposit. The skiagraph (Fig. 44) is presented upon p. 252. In this connection an interesting clinical phenomenon is shown in Fig. 38, which illustrates a very material apical shrinkage noted upon inspection. The patient, aged twenty, was sent to Colorado January 17, 1907. In spite of a loss of seventeen pounds in weight, with persisting fever and slight cough, the physical and bacteriologic examinations failed to disclose the slightest evidences of tuberculous infection. The apical percussion borders were perfectly normal, despite the extreme visible retraction upon the right side. Another patient, aged twenty-seven, arrived in Colorado in the latter part of 1907 with distinct physical evidences of pulmonary tuberculosis. The shrinkage of apical percussion boundaries was pronounced at the right apex,

although the other physical signs pointed to an absence of tuberculous infection at this region. Signs of slight infiltration with moisture were detected, however, in the left lung, especially from the third rib to the

Fig. 38.—Pronounced visual retraction, right apex, without tuberculous involvement.

base. Upon *x*-ray examination it was found that the tuberculous process was limited solely to the left lung, without evidence of apical involvement upon either side. The extent of the dissimilarity of percussion outlines at the apex is shown in Fig. 39. In Fig. 6 are shown practically

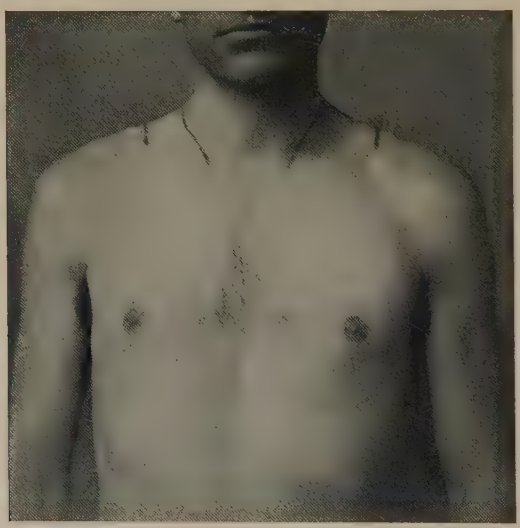


Fig. 39.—Pronounced shrinkage of the outline of percussion resonance at right apex, despite absence of tuberculous involvement in this region. Physical evidences of a tuberculous process perfectly defined in left lung. (Compare with radiograph, Fig. 53.)

uniform resonant boundaries at the two apices upon careful percussion. If anything, the area of resonance was slightly smaller at the right apex. Reference, however, to the skiagraph (Fig. 45) reveals an appreciable

shadow at the right apex, suggesting the likelihood of a greater difference in the percussion borders than was found to exist. A patient, aged twenty-eight, was sent to Colorado in October, 1907, for suspected pulmonary tuberculosis, presenting a history of pulmonary hemorrhage. Despite a well-marked shrinkage in the outline of percussion resonance at the left apex, physical examination of the chest was in other respects entirely negative. The bacteriologic findings were also negative. After several weeks a pronounced hemoptysis took place, apparently adding to the significance attaching to an unquestioned disparity in the apical outlines. The outlines of percussion resonance upon the two sides are shown in Fig. 40. As illustrative of the very pronounced unilateral apical shrinkage in connection with advanced tuberculous change the following case is of some interest. A young man came under my observation in the

Fig. 40.—Easily recognized change in the borders of apical percussion resonance without other physical signs.

summer of 1907, presenting physical evidences of rather extensive tuberculous involvement of the right lung, with slight infiltration in the upper left. The extent of visual unilateral retraction may be noted by reference to the accompanying photograph (Fig. 41). By comparing with Fig. 56, an explanation of the shrinkage is found in the destructive tuberculous change at the apex. In view of the experience afforded by the observation of the above and similar cases, it is apparent that the significance of the percussion outlines at the apices is subject to considerable variation.

The auscultatory signs of moderate infection are modifications of the normal respiratory murmur, adventitious sounds or râles, changes in the vocal resonance and in the whispered voice.

Modifications of the normal respiratory sounds partake of the general type of bronchovesicular respiration, which has been described.

True bronchial breathing is rarely observed in cases of partial consolidation, although the bronchial element may markedly predominate over the vesicular. The changes relating to intensity, pitch, duration, and quality of the inspiratory and expiratory sounds have been dwelt upon at such length in the preceding chapters that further description is unnecessary. It must be remembered that the recognition of bronchovesicular breathing at the right apex is possessed of far less significance than at the left, owing to the physiologic difference between the two apices.

The adventitious sounds or râles incident to this class of cases may assume the same general characteristics as those occurring in incipient stages, being of an explosive, crackling type and recognized at the end of inspiration following a cough. More frequently, however, they are distinctly moist and bubbling, exhibiting variations in size and easily appreciable without cough during expiration as well as inspiration.

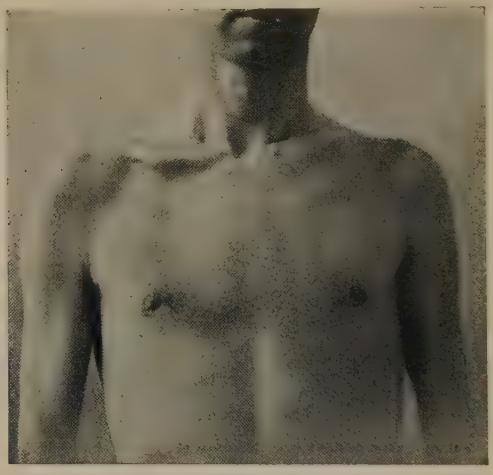


Fig. 41.—Pronounced visual retraction, right apex. (Compare with cavity formation shown in radiograph, Fig. 56.)

The râles may be elevated in pitch and consonating in character, denoting their origin in bronchial tubes surrounded by indurated pulmonary tissue.

The physical signs pertaining to the spoken voice represent important changes in the vocal resonance over the partially solidified lung. The degree to which the voice-sounds are exaggerated in intensity and modified in pitch and quality, has been explained to vary materially according to the extent of consolidation. A very important sign is the *intensification of the whispered voice* in the presence of slightly consolidated lung. This increased transmission, together with a slight elevation of pitch and change of quality, antedates considerably the recognition of bronchovesicular breathing.

It is sometimes possible to detect an increased intensity of the normal heart-sounds on account of their conduction through solidified lung.

CHAPTER XXXVI

ADVANCED CASES

Patients conforming to this group usually exhibit a striking combination of physical signs. Exploration of the chest is important not so much as a means of diagnosis as a matter of clinical exactitude and as a feature of prognosis. Although extensive cavity formation may be present in some individuals exhibiting every external evidence of health and vigor, yet in a large number of cases the general appearance of the patient is highly suggestive of the disease. Emaciation, pallor, dyspnea, and cyanosis are often pronounced. The skin of the body may be dry, harsh, or even scaly, and the hands thin, cold, and clammy. The fingers may be elongated, with tapering extremities and incurving nails, or the ends distinctly clubbed. The neck is thin and appears

Fig. 42.—Illustrating an area of well-defined visual pulsation in a patient with extensive tuberculous involvement of the left lung, with marked fibrosis. Note the slight deflection of the tip of the sternum toward the unaffected side. (Compare with radiograph, Fig. 79.)

unduly long. The ears stand out prominently from the sides of the head, and are often waxy, bloodless, and almost transparent. The breathing is at times labored, with the action of the accessory muscles of respiration prominently displayed. The nose may be pinched, the eyes sharp and bright, the hair dry and lusterless, and the face pallid, cyanotic, or flushed. The complexion is sometimes remarkably pale and clear, exhibiting strikingly a delicate plexus of superficial veins. The patient frequently assumes a pronounced stooping posture, the general attitude being that of marked debility. In addition to the drooping of the shoulders, the scapulæ are very conspicuous and suggest the oft-noted resemblance to wings. The changes noted upon inspection, with

especial reference to the thorax, aside from its occasional conformity to the phthisical habitus, partake chiefly of flattening, retraction, and impaired mobility. These differences may affect chiefly one side or involve the entire chest. Unilateral shrinkage may be sufficient to transform completely the contour of the thorax and greatly restrict the respiratory excursion. There may be resulting curvature of the spine and dislocation of the sternum. If the contraction change is present to a marked degree upon the left side, a large portion of the heart is denuded of its pulmonary covering, and there result visual pulsations in the third or fourth interspaces. The cardiac apex impulse is also subject to considerable dislocation, being pulled toward the affected side, as has been described.

The changes observed upon inspection are subject to ready confirmation by palpation, which also serves to elicit certain points of tenderness and a notably increased fremitus. Rhonchi from the

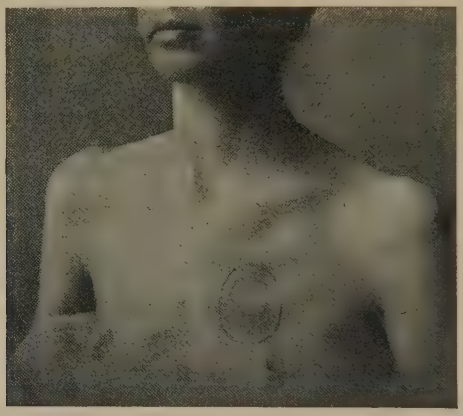


Fig. 43.—Representing visual cardiac impulse in a patient with very advanced tuberculous change in the left lung. The tuberculous process in this lung has been of long duration, and the fibroid contractile change is very pronounced. The wavy, undulatory impulse is detected throughout the larger circle, whereas the inner represents the location of a very pronounced impulse.

bronchial tubes may be recognized in some cases with the hand laid against the chest-wall.

Percussion may yield information of a varied and definite character, but this method of examination alone is incapable of affording an exact diagnosis of the morbid pulmonary conditions. In advanced consumption percussion changes may relate to the entire disappearance of pulmonary resonance, diminution of intensity, elevation of pitch, and differences of quality.

Total flatness results from an area of complete pulmonary consolidation, but it is seldom that a single lung is solidified to the same degree throughout its entire area. Complete absence of resonance in pulmonary tuberculosis may also be due to complicating pleural effusions or pneumopyothorax, as well as to solid lung and thickened pleura.

Diminished intensity of pulmonary resonance exists wherever the air-content is appreciably lessened in a given portion of the chest, and is observed in connection with an elevation of pitch. Small deep-seated areas of partial consolidation may escape detection because of the resonance of intervening normal lung tissue. Therefore the location and

size of the involvement are factors of considerable importance as regards the resulting changes in percussion resonance. Owing to the thick muscles of the back, it is impossible to elicit dulness upon gentle percussion unless the area of consolidation be of considerable size. Save at the apices, it is doubtful if changes of percussion resonance can be noted over a superficial area of less than four or five centimeters in diameter, or at a depth of over four or five centimeters from the surface. The manner of percussion and the variations of resonance have already been sufficiently discussed.

Differences in quality involve necessarily a diminution of the vesicular element and a corresponding increase of the tympanitic. Owing to the varied physical conditions obtaining in the midst of the destructive change incident to advanced consumption, the resonance may be purely tympanitic, assume the cracked-pot character, or present an amphoric intonation. Strictly speaking, the cracked-pot and the amphoric resonance constitute forms of the tympanitic, differing from it only by virtue of certain modifying attributes. In consumption the recognition of any one of these three varieties is suggestive of the presence of a pulmonary cavity. As has been shown, however, percussion signs are of but little value in the determination of this condition. The purely tympanitic type may occasionally be observed in late consumption over large cavities, and rarely over a consolidated upper lobe, as a result of the transmission of air vibrations from the trachea and primary bronchi.

The descriptive appellation "cracked-pot" resonance has frequently been regarded as definitely pathognomonic of pulmonary excavation. While this sign may be elicited now and then in the percussion of pulmonary cavities, it represents but comparatively little value as a cavity sign *per se*. As previously stated, it is frequently absent over pulmonary cavities, and is often obtained when no cavity exists.

The conditions responsible for the production of the peculiar musical intonation characterizing amphoric resonance have been described.

In addition to elevations of pitch commonly noted over consolidated lung, certain modifications are sometimes recognized over localized areas in the later stages of consumption. The various changes of pitch elicited during percussion of pulmonary cavities have been described sufficiently under General Physical Signs.

In the midst of extensive fibrosis the normal percussion boundaries are sometimes distorted to a remarkable extent, this being particularly true of the heart.

The influence of intrapleural conditions in producing changes of percussion outlines will be discussed in connection with Complications.

Upon auscultation in the midst of advanced infection there may be found the greatest possible deviation from the normal respiratory sounds and those of the spoken and whispered voice. The intensity of the breath-sounds may be diminished in some cases through narrowing of the lumen of the bronchi from tubercle deposit, and in others through the accumulation of thick, tenacious secretions in the tubes. They are reduced at times by an associated emphysema, an accompanying pleural effusion, or extensive pleuritic adhesions. In addition to the marked thickening of the pleura with contraction changes incident to fibrous tissue proliferation, there may exist an obliteration of terminal bronchioles as a result of the cicatrizing process. The

breath-sounds are rarely suppressed altogether in consumption, though this may result upon one side from the temporary occlusion of a bronchial tube. They may be absent also in areas of complete pneumonic consolidation, excessive fibroid change, pleurisy with large effusion, closed pneumothorax or pyopneumothorax, and severe pulmonary edema. Among consumptives an increased intensity of the respiratory sounds may be recognized in one lung when the respiratory function of the other is impaired to a great extent as the result of disease. This vicarious or supplemental type of respiration may obtain over small localized areas, not uncommonly at the apices, and is due to the compensatory activity of the non-tuberculous tissue. It is rarely recognized by clinicians over circumscribed regions, although patches of emphysema in tuberculous lungs are exceedingly numerous at autopsy. The chief distinguishing characteristics of the breath-sounds in advanced phthisis relate to changes in pitch and quality, which are included under bronchial, bronchovesicular, cavernous, amphoric, and the metamorphosing respiration. These types of breathing have been described at length under the General Physical Signs.

Changes in the duration of the sounds are sometimes observed, but these are of slight practical importance in comparison with the more striking respiratory changes during advanced tuberculous involvement. Interest attaches to the shortening of the inspiration and the prolongation of the expiration incident to bronchial breathing, and the lengthened expiration of cavernous respiration.

The râles of advanced phthisis are of medium size or coarse, and bubbling or gurgling in character, in contradistinction to the finer clicks or crackles recognized in early cases. They are heard upon easy breathing, the cough being by no means a necessary factor for their production, save in areas of recent involvement. They are high in pitch in proportion to the degree of pulmonary consolidation. The adventitious sounds do not, as a rule, derive their origin from the finer tubes, except in freshly infected regions. The size of the râle corresponds to the size of the tubes and the pulmonary cavities from which the sounds emanate. When the cavity has attained a fair size, the râle becomes gurgling in character and metallic tinkling is not altogether uncommon.

The vocal resonance is usually much intensified in advanced phthisis. As a result of the consolidation of lung or the presence of pulmonary cavities, changes in the pitch and quality of the spoken voice are also recognized, characterizing bronchophony and pectoriloquy. While the sound heard over cavities in the midst of pulmonary consolidation may partake of the bronchophonic character to some extent, bronchophony is heard chiefly over solidified lung. In the same manner pectoriloquy may be recognized over areas of both consolidation and excavation.

Attention has been called to the changes in the whispered voice as a result of tuberculous infiltration and cavity formation. Pulmonary cavities may occasion a marked increase in the intensity of the whispered voice, without *necessarily* involving appreciable changes in pitch and quality. Over thoroughly consolidated areas, however, the whispered resonance becomes high pitched and tubular in quality, corresponding to the sound of expiration in bronchial breathing. Whispering pectoriloquy and the whispered amphoric echo may also be recognized. It may be well to recapitulate briefly the physical signs of pulmonary cavities, but it must be remembered that their recognition in many

cases is not nearly so simple as would appear from text-book description. There may be detected occasionally, upon percussion, tympanitic resonance, amphoric resonance, or cracked-pot resonance; Wintrich's change of pitch; Wintrich's interrupted change of pitch; or Gerhardt's change of pitch. Upon auscultation there may be elicited cavernous breathing, vesiculocavernous breathing, bronchocavernous breathing, amphoric breathing, gurgling cavernous râles, metallic tinkling, increased vocal resonance, with or without bronchophonic characteristics, pectoriloquy, amphoric voice, the cavernous whisper, and whispering pectoriloquy.

Many of these signs may be recognized under conditions other than pulmonary excavation, and, on the other hand, cavities may exist without the recognition of a single physical sign. They may be detected with ease at certain periods and escape recognition at other times. The very fact of the intermittency of the physical signs furnishes exceedingly strong evidence of pulmonary excavation. Failure to recognize the physical signs in such cases is explained either by the presence of large masses of mucopus in the tubes, completely obliterating their caliber, or by the filling of the cavity itself with purulent secretion.

PART IV

DIAGNOSIS AND PROGNOSIS

SECTION I

DIAGNOSIS

CHAPTER XXXVII

PRELIMINARY CONSIDERATIONS

Diagnosis is by far the most important consideration pertaining to the general subject of pulmonary tuberculosis. In no other disease is this of more surpassing moment. It is scarcely conceivable that any uncertainty should exist in the recognition of moderately advanced phthisis, for the history, subjective symptoms, and physical signs present a clinical picture so typical as almost to preclude the possibility of error. Even when the constitutional symptoms are, perhaps, of doubtful import, the diagnosis is comparatively simple in the vast majority of instances through recourse to the physical signs, bacteriologic evidences, *x*-ray examination, and, when necessary, the tuberculin tests. The incipient cases present the only reasonable difficulties in the way of accurate diagnosis, and it is in precisely this class that the early recognition of the disease is of the utmost consequence.

Consumption has been shown to be a distinctly curable disease in the sense of its permanent arrest. It is known that a large proportion of the human race at some time in their lives unconsciously harbor tuberculous lesions, and that complete recovery frequently takes place by virtue of an inherent tendency exhibited by the individual toward an encapsulation of the tuberculous process. The practical effectiveness of the natural constructive forces which constitute the fundamental basis of any successful effort toward arrest depends very largely upon the *time of the definite recognition of the disease* and the *adoption of rational management*, an early diagnosis usually insuring a good prognosis. While strikingly gratifying results may sometimes be secured even among far-advanced cases, a uniformly successful issue may be expected only in the incipient stages. Early cases of tuberculous infection are of vastly greater importance than those of the advanced type, by virtue of the more favorable ultimate prognosis and the avoidance of an indefinite period of invalidism. The majority of consumptives with slight involvement may justly anticipate an arrest of the tuberculous process and a more or less complete restoration of their former health and vigor. It follows that the direction of such cases is vested

with the assumption of greater responsibility than attaches to the management of desperate patients, for whom the future holds but little hope of restoration to their former activity and usefulness. Thus, for humanitarian and economic reasons, early diagnosis assumes a position in the general consideration of consumption of infinitely more momentous consequence than any other phase of the tuberculous problem. No further commentary is required upon the frequency of delayed diagnosis than my report, a few years ago, of an analysis of 1700 cases of pulmonary tuberculosis observed in private practice. A more heterogeneous lot of consumptives it would be impossible to imagine. A large majority of these were of an advanced type, and many died shortly after arrival. A vast number were in greatly impoverished circumstances. Physical signs of advanced tuberculous infection were found in each lung in 69.1 per cent. of the cases, while in 53.05 per cent. there were presented unmistakable symptoms of severe systemic disturbance, including the fever of mixed infection, emaciation, weak and rapid pulse. The physical signs of excavation, in addition to the above, warranted their classification as advanced cases. From a critical analysis of the history, which may be accepted as definitely accurate, it was found that twenty and one-third months was the average period of delay following the clinical onset before arrival in Colorado.

It is, indeed, lamentable that thousands of lives are sacrificed annually on account of the tardy recognition of tuberculosis and the deferred institution of energetic management. It is charitable to believe that this distressing exhibition has been occasioned through inability to appreciate the significance of the rational symptoms, to recognize accurately the physical signs, and to interpret properly their import. An explanation of the surprising lack of familiarity with some of the considerations pertaining to the diagnosis of pulmonary tuberculosis is found in a superficial knowledge of the fundamental principles of practical medicine. Mention may be made of failure to elicit essential historic facts, to emphasize and group rational subjective symptoms, and to observe correct methods of physical exploration. A faulty technic in the examination of the chest may result from inadequate training or insufficient care. In the majority of cases the available data for diagnosis have been amply sufficient to warrant its provisional establishment long before the medical attendant has awakened to a realization of his responsibilities. This is partly explained by the fact that many cases of consumption exhibit a slow and insidious onset, not calculated to inspire apprehension on the part of the patient. Frequently the symptoms are not such as to awaken the suspicion of the physician, and the physical examination, if made at all, is practised in so superficial a manner as to preclude accurate results. In many cases this is not conducted until a provisional diagnosis is apparent from the constitutional symptoms. At times the onset may be so acute in character as to simulate other diseases, and obscure, for a considerable period, the true nature of the affection.

Perfect accuracy of diagnosis may be established by the recognition of the tubercle bacillus, but not always before the destructive process has become advanced and the constitutional disturbances pronounced. The physical signs occasionally furnish indubitable evidence of a recent active infection long before bacilli appear in the sputum. In other cases the history and subjective symptoms

afford provisional, if not conclusive, evidence of a latent concealed lesion despite the absence of bacilli and of well-defined physical signs.

Early diagnosis is a matter of great simplicity when bacilli are demonstrable, but their presence in the sputum is dependent upon caseation of the tuberculous area and upon their evacuation by way of a small bronchus. Thus it happens that there is not always a uniform relation between the bacteriologic evidences and the physical signs. It is not unusual to discover bacilli when no physical evidence of existing tuberculous involvement can be obtained, even upon the most rigid examination. On the other hand, the microörganisms may be exceedingly scanty or absent altogether, when an apparent activity of the disease is shown by the physical signs and general subjective symptoms. Later the bacilli may become decidedly more numerous, notwithstanding a pronounced improvement both in the pulmonary and in the general condition. I have under my care at the present time a gentleman who illustrates such possibility. Upon arrival in Colorado without having secured improvement during six months' residence in a well-known sanatorium, he exhibited a daily temperature elevation with considerable dyspnea upon exertion. Examination of the chest disclosed the presence of extensive active tuberculous involvement of each lung. Upon the right side the affected area extended from the apex to the fourth rib and to the lower edge of the shoulder-blade; on the left side, from the apex to the fifth rib in front, and from the apex to the very base behind. Throughout these regions fine and medium-sized moist râles were easily recognized after a cough. The expectoration, amounting to about two ounces in twenty-four hours, contained very few bacilli. The patient has gained forty pounds in weight, presents no fever at any hour of the day, coughs but little, and has comparatively slight expectoration. There is marked improvement in the general health, and examination of the chest reveals a pronounced gain in the tuberculous process, yet the bacilli have increased to an amazing degree, all specimens of sputum being literally "peppered."

CHAPTER XXXVIII

PROVISIONAL DIAGNOSTIC FACTORS

Attention is directed to the consideration of early diagnostic features, which antedate, in some cases, the appearance of bacilli or the recognition of well-defined physical signs. These factors relate to the family as well as the personal history, and include opportunities for infection and the influence of previous diseases.

FAMILY HISTORY

A tuberculous family history was formerly regarded to be of great diagnostic significance, but its importance is known to have been vastly exaggerated. While a degree of clinical interest attaches to a record of tuberculosis among immediate antecedents, it is extremely doubtful

if any reliable conclusions can be adduced as to the greater likelihood of infection by virtue of hereditary predisposition. To say the least, no authentic evidence has thus far been presented to establish an invariably increased susceptibility to the disease among the descendants of individuals eventually succumbing to pulmonary phthisis. Unfortunately, as a result of the misleading import of an excellent family history, many a consumptive has been compelled to pay the penalty of a grossly delayed diagnosis with the chances for recovery greatly reduced. Others in perfect health, yet with knowledge of antecedent infection, have supposed themselves under an impending shadow of disease and endured unceasing apprehension.

As a matter of diagnosis *per se*, a tuberculous family history has but slight, if any, import, though in some cases it should not be regarded as altogether valueless. A negative family history is unworthy of the slightest consideration in an effort to establish a diagnosis in the midst of obscure conditions. *Per contra*, a positive history, unless especially pronounced and extending to brothers and sisters, should not unduly influence a diagnosis otherwise more or less doubtful. There should be the same unequivocal interpretation of physical signs and the same diagnostic significance attached to subjective symptoms in all cases, regardless of the fancied influence of inherited predisposition.

ACQUIRED PREDISPOSITION

By acquired predisposition is meant an added susceptibility to the disease through the operation of certain causes which diminish individual resistance. Among these are included overwork, either physical or mental, oppressive cares and responsibilities, sleepless nights, despondency, alcoholic or sexual dissipation, financial reverses, domestic infelicities, social excesses, and a multitude of burdens incident to our modern civilization. The influence of these several features of everyday life in preparing the soil for a non-resistant reception of tubercle bacilli is too thoroughly recognized to warrant elaboration. Furthermore, the relation of these component factors to the general problem of tuberculous transmission has been discussed at some length under Conditions Influencing Infection. Their practical significance from the standpoint of diagnosis, in cases admitting of reasonable doubt, should ever be borne in mind. It is apparent that a thorough investigation concerning the previous environment in connection with associated facts pertaining to the history may furnish information of decided diagnostic value.

OPPORTUNITIES FOR INFECTION

A review of the personal history should include a scrupulous search for all possible sources of individual infection. This necessitates an inquiry into details which is frequently tedious, but nevertheless essential. An all-important consideration relates to the intimacy of contact, if any, with a consumptive. Upon admission of such association the investigation should proceed concerning the time that this existed, the condition of the patient, the final termination, and the disposal of the sputum. In many instances equal significance may be attached to the presence of phthisical patients in workshops, stores, and offices, as in the family. Surprising difficulty is sometimes

experienced in an effort to elicit information of a reliable character concerning the possibilities of infection from contact with infected invalids. An account is often given of the death of a relative from so-called "bronchitis," "asthma," "pneumonia which did not clear," "chronic pleurisy," "general debility," especially in the aged, "child-birth," etc. A careful inquiry will frequently disclose the history of a prolonged illness, characterized by pulmonary hemorrhages, fever, night-sweats, progressive emaciation with persisting cough and expectoration, thereby revealing the true nature of the disease.

The existence of tuberculosis, either in the family circle or within the immediate business environment of the individual, having been demonstrated, it is desirable to ascertain regarding the intimacy of association. If affecting husband or wife, sisters or brothers, information should be secured as to whether or not the two occupied the same apartment or the same bed. Often it is found that one was engaged in nursing the other, and confined for many hours by day and night within the sick-room, which, perchance, was overheated and insufficiently ventilated. The *duration of the period* during which close association took place possesses considerable interest. If prolonged during several months, the suspicion of an acquired infection would be rendered greater than if for a relatively short time. The likelihood of contracting the disease varies somewhat according to the condition of the patient. Some consumptives with incipient or moderate involvement and a small amount of tuberculous sputum constitute but a slight element of danger to their associates. Others with advancing excavation, excessive expectoration, and marked physical exhaustion incident to the later stages represent a constant source of peril to those about them.

By far the greatest importance relates to the information acquired concerning the disposal of the sputum. This factor alone measures to a great extent the degree of danger attaching to the presence of a pulmonary invalid. If the receptacles for expectoration be ordinary cuspidors, handkerchiefs, rags, or newspapers, the possibilities of infection are, indeed, sufficiently obvious. Many patients, however, imagine that they are scrupulously careful in this matter, although, upon inquiry, they are found guilty of gross hygienic errors. Very recently I have questioned a lady of the utmost refinement who protested that she observed extraordinary precautions with reference to the sputum. I soon found that she coughed a great deal in the night, and was in the habit of spreading newspapers upon the floor at the side of the bed upon which to expectorate. The enormity of the offense was intensified by the presence, in the family, of a year-old baby.

The practical consideration regarding the sputum relates not so much to its chemic disinfection as to keeping it moist, for if evaporation can be prevented, the danger of infection is reduced to a minimum. Expectoration into shallow cuspidors with small apertures and broad upper surfaces is almost as bad as, if not worse than, upon newspapers, as adherent particles of sputum are frequently allowed to remain for an entire day. The small sputum-cups at the bedside, even though containing water or strong disinfecting solutions, are notoriously inadequate unless covers are provided. It is almost impossible for the bed-ridden consumptive resorting to the use of these receptacles to deposit the sputum directly into the solution, as inevitably a portion will cling

tenaciously to the sides of the cup. The drying of such sputum proceeds with the utmost rapidity, and results in an element of veritable danger.

In the exhaustion and sometimes the delirium incident to the last stages the possible sources of infection in the sick-room are greatly enhanced. The dangers of contamination of the bed-clothes, walls, and carpets are exceedingly great, as the patient, no matter how carefully instructed, has lost to a degree his appreciation of individual responsibility.

Thus in doubtful cases a careful investigation relative to the opportunities for infection may aid in the establishment of at least provisional conclusions.

PREVIOUS DISEASES

A history of certain diseases prior to the development of tuberculous manifestations is possessed of undoubted diagnostic significance, both in children and adults. A severe attack of measles, whooping-cough, typhoid fever, pneumonia, pleurisy, or influenza may represent the first signal of approaching danger. The symptoms of pulmonary infection may develop shortly after the subsidence of the acute disorder, or only after prolonged intervals, when the restoration to health is apparently complete. A diagnosis of the tuberculous nature of a sthenic pneumonia may be made in some cases from the tenth to the fourteenth day, but in others not until after the lapse of several weeks. The resolution, though slow, may appear sufficiently progressive to disabuse the mind of the clinician concerning the possibility of tuberculosis. Sometimes there is a seeming recovery from the initial disease, save for the failure of the patient to regain a full measure of strength and vitality. Frequently no suspicion of the onset of consumption is entertained, the pneumonia being supposed to furnish an ample explanation for the impaired general condition. In a similar manner a protracted convalescence from typhoid fever or malaria often represents the period of early tuberculous manifestations. In many of these cases the tuberculous infection is present from the very beginning, but the evidences of pulmonary invasion may be recognized only after a considerable interval. I have observed a few cases in which the possibility of a pure tuberculous infection with initial typhoidal manifestations could be completely eliminated, yet after a slow and tedious convalescence from unquestionable typhoid the subjective and objective evidences of tuberculosis were detected.

The history of an idiopathic pleurisy with or without effusion is assuredly a factor of considerable importance in cases presenting symptoms and signs of doubtful interpretation. A very large proportion of idiopathic pleurisies are known to be tuberculous in character, irrespective of the later appearance of distinct pulmonary lesions. Sixty-seven of my cases out of a total of 2070 present the record of a previous pleurisy. The history of pleurisy without assignable cause should suggest, even in the absence of well-defined clinical manifestations, at least a strong possibility of existing pulmonary tuberculosis.

In obscure cases the history of influenza, either recent or remote, furnishes still another landmark pointing toward a tuberculous process. The relation of this infection to the subsequent development of tuberculosis has been discussed in earlier pages. It has been contended by

some that the onset of consumption following influenza is accounted for largely by the means offered for the more extensive distribution of tubercle bacilli. This hardly appears reasonable, a simpler explanation being found in the increased vulnerability of the tissues through the influence of a prevailing epidemic, in connection with the frequency of latent infections. In any event the symptoms of consumption have often appeared some weeks or months after an attack of influenza in individuals formerly in perfect health. The previous occurrence of influenza, therefore, in cases admitting of considerable doubt, must be accounted a factor of some diagnostic importance.

The etiologic significance of pulmonary hemorrhages has been reviewed in a preceding section. The fact that about 20 per cent. of all pulmonary hemorrhages appear in the midst of apparent health as the first symptom referable to tuberculosis indicates the vast importance to be attached to this history in doubtful cases. As previously asserted, a moderately severe hemorrhage may take place in the entire absence of subjective symptoms or of physical signs, even upon rigid physical examination. While the history of a remote pulmonary hemorrhage, with or without occasional recurrences, does not yield indisputable testimony as to the existence of a possible concealed focus of tuberculous infection, the fact remains that such admission, in association with constitutional symptoms, even of a doubtful character, must be regarded as strongly in favor of pulmonary tuberculosis. In each instance of pulmonary hemorrhage of uncertain origin, however, a pronounced effort should be made to determine beyond peradventure the absence of other conditions capable of explaining its occurrence. A provisional conclusion as to the tuberculous significance of pulmonary hemorrhage can be reached only by a careful systematic elimination of other possible etiologic factors, as mitral disease, vicarious menstruation, purpura hæmorrhagica, etc.

CHAPTER XXXIX

PRESENT CONDITION

The principal diagnostic features relating to the character and extent of constitutional disturbance are cough, loss of weight, fever, and acceleration of pulse. These, in connection with the physical and bacteriologic evidences, usually yield information of an undoubted character.

COUGH

The cough, which has been described at length under General Symptomatology, is often the first subjective manifestation of pulmonary tuberculosis. It is more frequently present than any other initial symptom, and at once attracts attention to some involvement of the respiratory tract. It often serves a useful purpose in arousing the early apprehension of patient and friends, and is of signal value in exciting the suspicion of the physician as to a possible tuberculous invasion. Upon investigation the cough may be found to be occasioned by catarrhal bronchitis or laryngitis, an elongated uvula, or a follicu-

lar pharyngitis. While frequently dependent upon conditions other than tuberculosis, its persistence in the absence of readily explained cause, particularly in combination with loss of weight or fever, should be construed as strongly indicative of a tuberculous infection, despite failure to elicit characteristic physical signs. *A negative exploration of the chest in such cases does not remove the burden of proof resting upon the examiner who doubts a tuberculous involvement.*

The cough of incipient tuberculosis is, indeed, a variable quantity. It may not be present at all, or its severity may be out of all proportion to other manifestations of beginning tubercle deposit. There is no relation whatever between this symptom and the nature or extent of the tuberculous process. In early cases the temperamental idiosyncrasies of the patient are apparently an important determining factor in the degree and character of the cough. This may consist merely of a slight clearing of the throat at intervals, or the cough may occur in severe paroxysms, with or without expectoration. It is frequently of a distinctly nervous type, in which event it may be accompanied by other evidences of hysteria. It is subject to much variation in the same individual, according to the influence of external causes and the facilities afforded for mental distraction. The cough of incipient phthisis is more likely to occur in the early morning and to disappear during the balance of the day. Hoarseness may develop during the latter part of the afternoon, or it may precede all other symptoms, and from its persistence afford a strong suspicion of an underlying tuberculous infection. The appearance of the cords may be almost normal, or there may be thickening and reddening from an existing catarrh in association with other laryngeal changes. In very early stages of consumption the diagnostic value of cough or hoarseness consists almost entirely of the suggestion offered to the examiner of possible intrathoracic disease. If the cough does no more in such cases than to emphasize the necessity of a thorough chest examination, and a judicial inquiry as to the significance of accompanying symptoms, this surely is sufficient to establish its clinical value.

LOSS OF WEIGHT

Loss of weight has long been regarded as one of the cardinal manifestations of consumption, but its diagnostic significance in incipient cases appears to have been exaggerated to a great extent. In very early cases the impairment of nutrition is but trifling or absent altogether. Slightly later in the disease it is an almost invariable accompaniment of other symptomatic disturbances, and is then highly suggestive of tuberculosis. As a general rule, patients exhibiting decided emaciation have been afflicted for a long time, and manifest other evidences of the tuberculous nature of the affection. Cases displaying pronounced loss of weight early in the disease are necessarily those of acute onset, with considerable elevation of temperature. In such cases the diagnosis is not made upon the basis of the diminished weight, but rather by virtue of the accompanying symptoms and physical signs. Even without cough, expectoration, or fever, if combined with loss of strength, shortness of breath, and acceleration of pulse, with failure of appetite without satisfactory explanation, emaciation strongly emphasizes the need of exhaustive physical investigation with *x*-ray examination and the employment, in occasional instances, of the tuberculin tests.

FEVER

The importance of fever is perhaps greater than that of any other subjective symptom during the early stage of tuberculosis. While its absence constitutes no argument for the exclusion of a positive diagnosis, its presence under certain conditions is assuredly a feature of exceeding diagnostic value. Statements of patients regarding the existence of fever are frequently unreliable. Many experience no sensations of increased warmth or flushing of the cheeks. These patients quite invariably deny the presence of fever, which is revealed only by the intelligent use of the thermometer. Almost to an equal extent is it unsafe to place dependence upon the reports of invalids who, without competent instruction, have been taking their own temperature. Nothing is more certain regarding the fever of phthisis than its extreme variability, not only at different hours, but upon succeeding days. It is clear that unless the temperature is taken frequently and systematically, the acquirement of accurate knowledge concerning the fever record is well-nigh impossible. It has been a source of ever-recurring surprise to learn in many individual instances that physicians were content to observe the temperature but once a day, and then only during the morning hours. A negative result often attends several observations of the temperature daily, despite considerable intervening elevations. To obtain approximately correct information the thermometer must be used in suspected cases at intervals of every two hours, and preferably during a period of several weeks. When practicable, the temperature should be taken by some person other than the patient, and a careful record maintained. I have observed many invalids who have been instructed by their medical attendants to avoid the taking of temperatures on account of a possible unfortunate mental influence. It is not uncommon to note, among nervous people, a tendency to take the temperature frequently, with an excessive mental perturbation following even slight elevations. In exceptional instances objections to the use of the thermometer may be sustained after the diagnosis has once been established, but during the period of early observation, in doubtful cases, its use should be insisted upon, regardless of all other considerations. Employment of the thermometer represents one of the old-fashioned principles of diagnosis, the careful and painstaking application of which, in recent years, too frequently has been overlooked. Notwithstanding irreconcilable differences in the various makes of thermometers, reasonably accurate results may be secured, provided the instrument is retained in the mouth for a sufficient time. One-minute or two-minute thermometers are often extremely unreliable. Regardless of the particular type employed, the instrument should be held under the tongue with the lips tightly closed for not less than five minutes, any shorter retention being practically valueless. As a general rule, the temperature should be taken indoors, as there is often noted in cold weather a difference of from one-half a degree to a degree, according as the patient is in the open air or in the house. I have found, during the winter, that patients necessarily housed upon stormy days exhibit a uniform elevation of temperature. The characteristics of the temperature which are of more especial importance are its irregularity and atypical course, its usual but not invariable rise in the evening, and the exhibition of an average for the day slightly above normal. Occasionally, in cases

with very incipient infection, the temperature is slightly elevated after a hearty meal, physical exercise, and during periods of temporary excitement. Fever in some cases may be expected to attend the time of menstruation and the ensuing few days. It is frequently present at noon, only to subside toward evening, or it may be absent during almost the entire day, and rise late in the afternoon. In children the range of temperature is usually higher than in adults, though not always. At the other extreme of life the fever is proportionately lower and sometimes absent altogether, in spite of the existence of an active tuberculous process. A diurnal range of temperature, which maintains an average somewhat above normal, without assignable cause, should direct suspicion toward a tuberculous involvement, even if accompanying symptoms are exceedingly indefinite.

ACCELERATION OF THE PULSE

There is often no characteristic change in the pulse during the incipient stage of consumption, it being apparently normal in very many cases. Sometimes, however, changes occur during the incipiency of the infection, and even before a demonstrable bacillary stage. The pulse is often of low tension, weak, irritable, or rapid. Tachycardia, from unknown cause, is particularly suggestive of tuberculous infection. While the heart and aorta are perhaps of small size in such cases, as stated by Brehmer, clinical verification is seldom possible. The pulse is subject to considerable variation as a result of comparatively trifling conditions, as slight exertion, animated conversation, or other causes of nervous excitation. A factor of some importance is the irritability and acceleration of the pulse upon change of position, although at rest it may appear entirely normal. This view is directly opposed to the opinion of those who maintain that the characteristics of the pulse are unmodified by change of position. Acceleration accompanying pyrexia is of less significance than that which results from emotional excesses suggesting nervous cardiac instability.

EXPLORATION OF THE CHEST

The results of physical examination, even in the incipiency of the disease, usually exceed in importance all other features of diagnosis. A detailed, painstaking examination immediately upon the development of suspicious symptoms may suffice to establish a diagnosis considerably in advance of the appearance of bacilli. Unfortunately, exploration of the thorax is often deferred until a provisional diagnosis has become apparent from the rational symptoms.

It is important to emphasize the necessity of a more strict and conscientious adherence to the principles of physical diagnosis, which are ignored in so many instances. Attention should again be called: (1) To the delay in insisting upon physical examination until long after the development of pronounced constitutional and pulmonary impairment; (2) failure to examine upon the bare skin, the presence of clothing effectually preventing any approach to accurate results; (3) neglect to examine the entire chest, the bases, interscapular spaces, and axillary regions often being overlooked, notwithstanding evidences of clearly defined tuberculous infection; (4) failure to utilize cough preceding forced inspiration in eliciting the presence of moisture in the finer tubes.

The physical signs of the various stages of consumption have been described in the preceding section, but it is, perhaps, well to review briefly a few features pertaining to cases of incipient infection. The attention of the examiner should be directed to a possible retraction at the apex and to a localized retardation of respiratory movements. Upon palpation he should carefully note the existence of increased vocal fremitus, particularly at the left apex. The absence of slight percussion dulness must not be misconstrued, the tuberculous process often being capable of recognition upon auscultation considerably before the evidences of consolidation are apparent. Especial attention should be given to outlining the boundaries of percussion resonance at the apices in order to determine the shrinkage from infiltration or contraction. Although the examiner must be on the alert to recognize minor changes upon auscultation, even before the appearance of moisture, the presence of *unilateral apical râles* are of especial significance, and are almost always pathognomonic of consumption. Considerable importance attaches to changes in the spoken and whispered voice. In cases of slight infiltration the spoken voice may exhibit merely an increased intensity of vocal resonance, but with a greater degree of consolidation distinct bronchophony is obtained. An element not always appreciated is an intensification of the whispered voice. This, if present at one apex, and particularly the left, suggests a diminution of the air-content of recent or remote tuberculous origin. The presence of moist râles, percussion dulness, increased fremitus, or vocal resonance, with unusual intensification of the whispered voice, are more or less easy of recognition in comparison with the finer deviations from normal respiratory sounds. For the detection of the latter changes the utmost concentration of the mind, added to a somewhat extended experience, is absolutely essential. It is customary to describe the modifications of pitch, intensity, quality, and rhythm of the apical respiration as bronchovesicular. It is difficult to conceive of any deviation from the normal vesicular respiration in early phthisis which does not entail changes conforming to this type of breathing. In the event of very slight pathologic change involving the mucosa of the finer tubes there may be noted but slight modification of the normal respiration. The vesicular element markedly predominates over the bronchial without appreciable abnormality in the pitch, intensity, or duration of the expiratory sound. The change from the normal may relate exclusively to the inspiration, and partake merely of a roughening of the sound, produced by the thickened mucosa, which impedes the free entrance of air. This may represent one of the very first auscultatory signs of incipient phthisis, but it is hard to imagine how any considerable obstruction of the lumen can exist without likewise interfering with expiration, prolonging its sound, and raising the pitch to some extent. The inspiratory sound in some cases may be interrupted, giving rise to the appellation "cog-wheel" respiration, but this is sometimes recognized among the non-tuberculous.

As has been explained, modifications of the respiratory sounds discoverable at the left apex are possessed of much greater significance than at the right on account of the normal disparity between the two sides. If these signs are detected at the left apex, they may be regarded as pathognomonic of a tuberculous process. The presence of *unilateral râles* at either apex is of infinitely greater importance. They may be

present in the morning and disappear in the afternoon, only to recur upon the following day. Indistinct and indefinite râles may assume greater prominence following the temporary administration of potassium iodid.

Through the detailed application of the principles of palpation, auscultation, and percussion, irrespective of the newer and special aids to diagnosis, the nature of the tuberculous process may be recognized in many instances prior to positive bacteriologic evidences.

SPUTUM EXAMINATIONS

The discovery of tubercle bacilli in the sputum furnishes the most convincing proof as to the true nature of the pulmonary affection. While their presence may be regarded as conclusive evidence, their non-recognition, save by an expert after repeated examinations, does not preclude their existence in the sputum. Their demonstrable absence from a single specimen, even following an exhaustive search in accordance with a careful technic, affords no absolute information as to the non-tuberculous character of the affection. The all too prevalent habit of delaying the diagnosis of consumption until the appearance of the bacillus is a practice calculated to relieve the physician of a portion of his ostensible responsibility, but in reality this constitutes a technical evasion of his moral obligation to the patient. The most pernicious feature of a diagnosis, founded exclusively upon the discovery of bacilli, relates to the unnecessary delay before remedial measures are adopted. This laxity is fraught with very considerable danger to the invalid, who, resting in a position of false security, loses not only valuable time, but a measure of *opportunity* as well, in the struggle to secure arrest after the so-called open stage of tuberculosis has developed. It is true that there is a certain burden of responsibility imposed upon the physician, who assumes to diagnose pulmonary tuberculosis without incontrovertible bacillary evidence of its existence. This obtains particularly on account of the radical advice necessarily given with reference to methods of living, suspension of work, change of occupation, severance from family, and recourse to favorable climates. On account of the involved responsibility and through motives of personal interest in the invalid and family, the clinician may often hesitate to pronounce sentence without the corroborative evidence furnished by bacilli. In cases in which the combined subjective symptoms and signs are strongly suggestive of a tuberculous process, there can be no greater dereliction of duty on the part of the physician, than to withhold the diagnosis until the appearance of bacilli. On the other hand, in the absence of clearly defined indications of tuberculous infection, an unqualified positive decision should not be reached through the uncertain interpretation of a single factor, even though possessed of considerable clinical interest. Among those who are apt to pride themselves upon a refinement of diagnosis, there seems to be a growing tendency to advocate unreservedly the rendering of an affirmative opinion *entirely* independent of the bacilli. In the interests of the profession and of humanity it is time a note of warning was sounded, for fear lest, in the midst of ultrascientific enthusiasm and through commendable pride in detailed clinical study, the swing of the pendulum may eventuate in ill-sustained notions, causing unnecessary suffering and

embarrassment to the supposed pulmonary invalid. It is well to maintain, as far as possible, a rational and moderate attitude with reference to the discovery of bacilli before making an unqualified diagnosis of consumption. Results which ultimately are to be satisfactory to the patient, relatives, and to the physician himself will be attained only through a careful weighing of all the evidences presented and a judicial determination of their combined import. A practical objection to withholding invariably the diagnosis until the recognition of bacilli arises from the fact that there are a considerable number of physicians who, through insufficient training and inadequate technic, are unable to detect bacilli until they are present in large numbers and the disease has correspondingly advanced. Another though less frequent source of error relates to the detection of supposed tubercle bacilli by superficial observers. It thus appears that the practical value of the sputum examination, no less than of the physical exploration, depends upon the ability and training of the examiner. The selection of barren particles of sputum, the making of a thick and uneven smear, carelessness in staining, insufficient decolorizing, and haste in the microscopic search, are among the more common causes of mistaken conclusions regarding the presence of bacilli. The manner of examination previously described may be modified by combining the decolorization and the counterstaining according to the method of Gabbet. After the initial stain is washed with water, this consists of drying the cover-glass for a few seconds in a solution composed of 25 c.c. sulphuric acid, 100 c.c. water, and 2 milligrams methylene-blue, following which the glass is again washed and examined after drying. The only advantage gained, which is very slight, relates to the shortening of the process, but the results are not quite so satisfactory as with the method described in an earlier chapter. If the bacilli are found to be absent after several examinations, more conclusive results may be obtained by treating the sputum with a solution of soda or potash and centrifuging.

CHAPTER XL

SPECIAL AIDS TO DIAGNOSIS

For general purposes the diagnosis can be made with sufficient accuracy and celerity without recourse to the newer methods or special aids. Delay has been occasioned, in the vast majority of cases, not through inability to utilize these methods, but on account of failure to recognize the ample subjective and objective clinical data already available. There are many difficulties in the way of establishing an exact and early diagnosis through the agency of special methods, the necessary restrictions upon their employment placing them beyond the immediate reach of the general practitioner. They may be regarded, however, as of value in very exceptional and obscure cases. The newer methods of diagnosis of special importance relate to the use of the tuberculin tests, animal experimentation, and the Röntgen-rays.

THE TUBERCULIN TEST

Save under very puzzling conditions, recourse to the old tuberculin of Koch by subcutaneous injection is quite unnecessary and unwarranted. When the diagnosis is sufficiently clear by other means, the tuberculin test presents no additional feature of value, while its employment, unless in the hands of a careful and experienced physician, is vested with certain possibilities of danger. Shortly after its introduction by Koch it was proclaimed by several students, as a result of considerable research and clinical observation, that the tuberculin served to renew the activity of previously latent foci, and to disseminate a general tuberculous infection. Radically differing views were entertained by pathologists as to its possible influence, at a time when it was used in larger doses than in recent years. It may be assumed at present that the tuberculin in carefully graduated doses in the hands of a skilled clinician is entirely harmless, the only danger resulting from its indiscriminate and careless administration. In like manner the possibility of correct conclusions following its use depends entirely upon a rigid adherence to certain precautionary measures, the reaction, if present, being of much or slight significance according to the conformity of its employment to certain well-recognized principles. The production of a general reaction, marked by temperature elevation and more or less constitutional disturbance, together with occasional local manifestations, constitutes the basis of the test. Some opposition to its use arises from the exhibition of a positive reaction in cases apparently not tuberculous, the variable degree of the reaction, and sometimes, though rarely, its entire absence in infected individuals. It is important to note, however, that when the reaction has occurred in the supposedly non-tuberculous, autopsy findings have often disclosed the presence of concealed foci of inactive infection. While this partly accounts for its exhibition among apparently healthy people, the very fact of latent tuberculosis among a large portion of the race detracts to some extent from the significance of the reaction among individuals suspected of early pulmonary lesions.

The occasional absence of reaction among the tuberculous is explained largely by failure of less practised observers to conform to a strict technic in the manner of its employment. The reaction has been found to be more pronounced in recent cases, and comparatively slight among the far advanced, the increased tolerance among the latter suggesting an effort of nature toward the establishment of partial immunity. It is possessed of but little diagnostic significance if administered in the presence of even slight elevations of temperature, a fever of over 99° F. being sufficient in many cases to preclude accurate diagnostic interpretations. Inasmuch as the reaction may be attended by fever ranging from one to three or four degrees above normal, it is readily apparent that a detailed record of the temperature, for several days preceding its administration, is essential. Before employing the test the temperature should be taken at not less than two-hour intervals during a period of two or three days, preferably a week, in order to avoid any confusion arising from ordinary fluctuations.

The reaction usually occurs in the neighborhood of the tenth hour, but may be delayed until the second day. It is sometimes accompanied by symptoms of more or less profound constitutional disturbance of one

or two days' duration, consisting of chill, headache, pain in back, limbs, and joints, nausea and vomiting, malaise, and general restlessness. These symptoms usually subside after a few hours. A local reaction, which is capable of recognition, is of more significance than the general disturbance. While the local manifestations are often of pronounced character in tuberculous involvement of the bones, joints, glands, and testicle, the detection of definite change in the areas of pulmonary infection is not always possible. My experience with the old tuberculin for diagnostic purposes has been very limited, having used the test as a last resort in but a very few doubtful cases. Ample opportunity has been afforded, however, to witness marked local reaction following the administration of the bacilli emulsion for therapeutic purposes. During the past year this agent has been given extended employment in selected cases. Thus means have been acquired for a study of the local reaction in a few conspicuous instances. In connection with the not uncommon aggravation of cough and the added amount of expectoration there has been found in some instances upon auscultation a temporary increase of moisture in infected areas. With the bacilli emulsion I have not been able to detect an appreciable modification of the former respiratory sounds, but this is reported to have been recognized at times after injection of the old tuberculin.

In making use of the diagnostic test the beginning dose should not exceed $\frac{1}{10}$ of a milligram, although some clinicians are accustomed to employ initial doses of two or three milligrams. There is nothing particularly to be gained by adopting the larger dose in the beginning, which in many cases results in extreme discomfort to the patient and presents certain elements of danger. If there is no reaction following its initial administration, a second dose may be given after the lapse of several days, during which time the temperature should be recorded with care in the same manner as prior to the first injection. In case of failure to react after smaller doses they may be gradually increased up to six or seven milligrams. It is not advisable to exceed this dose in any event, and very rarely justifiable to resort to over two or three milligrams. The only objection to the use of the smaller doses is the possible establishment of a gradual tolerance on the part of the system and the consequent failure to secure reaction. An intelligent use of the tuberculin demands the exercise of the utmost care in adjusting the size of the dose. This arises partly from the necessity of diluting the crude product. It is well to make the dilution at the time of its administration, as the product becomes inert after remaining diluted for more than forty-eight hours, although some continue its use for two weeks after it has been prepared. The best method of dilution is the use of 0.5 per cent. of phenol in distilled water. All the appliances employed in its administration, which include the syringe, tubes, pipets, etc., should be made absolutely sterile by boiling, preceding each injection. The most rigid aseptic precautions are necessary to avoid the unpleasant consequences of infection. Those who make frequent use of the tuberculin for diagnostic and therapeutic purposes are found to favor various sites for the point of injection, but it is extremely doubtful if this is of special moment. It is usually better to make the injection deeply into the muscle of the back rather than subcutaneously. The skin should be thoroughly cleansed and rendered aseptic with alcohol or ether. A sterile pad should cover the point of injection for at least

twenty-four hours. Inhalations of tuberculin for diagnostic purposes by means of a specially devised vaporizer have recently been employed, but the results thus far are insufficient to justify conclusions other than as to the convenience of the method.

While the legitimate scope of the tuberculin test, when employed subcutaneously for diagnostic purposes, is extremely small, and its field of usefulness confined exclusively to a few doubtful cases otherwise incapable of precise determination, it, nevertheless, is safe to conclude that its intelligent employment in this manner is not only harmless, but possessed of a high degree of diagnostic value.

A recent *important modification* of the tuberculin test has been introduced by Calmette and Wolff-Eisner, known as the *ophthalmo-tuberculin reaction*. By means of this method the tuberculin test represents a most valuable aid to diagnosis, and its careful employment seems to be divested of all disagreeable or dangerous features. The principle upon which is based the topical application of tuberculin for diagnostic purposes is found in the local reaction exhibited by infected individuals following the administration of the toxins of the tubercle bacillus. This sensitiveness of the tissues was noted long ago following the use of Koch's old tuberculin. While local lesions were by no means uniform, the frequency of hyperemia and swelling at the site of injection was often the subject of comment. Also in animal experimentation it was noted, as stated in other chapters, that in many instances an acquired partial immunity after primary inoculations was suggested by the more intense local reaction attending the second injections. Reference is made in the chapter upon Immunity to the action of the toxic substances in the presence of the tuberculous foci of infected individuals. The development of local lesions following the subcutaneous employment of tuberculin suggested a response of the tissue-cells as a result of the absorptive products from the foci of infection.

The first practical application of these principles of local reaction in tuberculosis was made by von Pirquet, who, after scarification, made topical application of tuberculin and noted localized swelling and congestion in tuberculous children. Calmette subsequently utilized the same principles by applying tuberculin to the conjunctiva. By the use of 95 per cent. alcohol he precipitated the tuberculous toxins from Koch's old tuberculin. After drying and dilution with 1 per cent. sterile water or normal salt solution, one drop was instilled into the eye. In from three to eight hours this was followed in tuberculous individuals by a local reaction, varying from a slight redness of the caruncle to an intense hyperemia of the conjunctiva, with considerable secretion and at times edema of the lids. The reaction remained well defined for three or four days, but rarely persisting for longer than a week. Among non-tuberculous individuals either a negative result was noted or else the reaction was mild and of short duration. The test has been applied by a considerable number of observers, who have reported in the main fairly uniform results corroborative of the conclusions of Calmette. Baldwin has recently reported his observations concerning the efficacy of this test, as made upon 137 cases, including 62 observed by Drs. Trembley, Allen, Twitchell, Brown, and Rathbun. Nearly all the individuals known to be definitely tuberculous displayed a positive reaction, the only exceptions being a case of miliary tuberculosis, a patient being treated with tuberculin, and a doubtful case with healed

lesion of long standing. Of the doubtful cases, only about one-fourth responded positively to the test, while approximately a like proportion of apparently healthy persons exhibited a definite reaction. Two strengths of a filtered sterile normal salt solution were used, and a measured drop representing 0.025 c.c. was instilled by means of a throttled eye-dropper. The solutions were sterilized by boiling after being sealed in small glass tubes. A 0.5 per cent. solution was employed in one eye, and in the event of a negative reaction a drop of a 1 per cent. solution instilled into the other eye after a lapse of forty-eight hours. The reports of many observers indicate that the reaction is valuable, but not entirely infallible.

Cohn reports that eight out of twelve typhoid patients reacted positively to instillation of the tuberculin. His own observations and the experiments upon 310 patients tested at Fraenkel's clinic point to the value of a positive reaction as presumptive evidence of tuberculosis. The reaction was obtained more frequently in patients in the early stages of tuberculosis than in those with far-advanced infection. Thirty-eight out of forty-one patients with incipient or moderate infection responded to the test, while but two out of forty-five in the later stages displayed a positive reaction. This suggests strongly that a negative response is possessed of but little value. Webster and Kilpatrick report a positive reaction in all individuals having tubercle bacilli in the sputum, and conclude that the reaction is of but little value in the doubtful cases, two individuals apparently well displaying a positive reaction. Downes, from an experience with twenty-four cases, is led to regard the test as of considerable value, as does Franke, MacLennan, Mallan, and Alessandri, the two latter being inclined to attach more importance to its reliability than many observers.

My own experience with the ophthalmotuberculin test has been limited in its application to forty-two cases. The physical and bacteriologic findings were clearly unmistakable in twenty-seven patients, the tuberculin reaction being positive in every instance. The diagnosis was doubtful in fifteen cases, and of these, four responded positively to the tuberculin test, while eleven exhibited no reaction whatever. Of the latter number, the family history, opportunities for exposure, previous history, and subjective symptoms suggested strongly the possibility of a tuberculous infection despite negative results of physical examination. In many of these cases a provisional diagnosis of tuberculosis had previously been made. Of the four doubtful cases who presented a positive reaction to the ophthalmotuberculin test, a definite diagnosis seemed impossible upon the basis of the physical signs or bacteriologic evidences. Varying degrees of reaction were exhibited among the twenty-seven patients, responding positively. In the latter cases the $\frac{1}{2}$ per cent. solution of precipitated tuberculin was invariably employed, the resulting inflammation being very pronounced in five instances and lasting for several days. The 1 per cent. solution was used only upon patients who did not react to the initial test. A drop was instilled into the other eye after an interval of two days, but in no instance was a reaction noted upon the employment of the stronger solution. An interesting feature was the delay of the reaction in a few cases. In one case the conjunctival inflammation did not appear until after the lapse of thirty-six hours, and in several the maximum intensity of the reaction appeared not until after eighteen hours. Fifteen patients submitting to the oph-

thalmotuberculin test had been subjected for variable periods to small weekly injections of bacilli emulsion. Of these, ten exhibited a much slighter reaction than those not subjected to tuberculin therapy. The test was not employed upon any individuals who were presumably well. Despite the comparatively small number of patients to whom the test was applied, the results thus far have seemed to offer abundant evidence as to its value in doubtful cases.

EXPERIMENTS UPON ANIMALS

The introduction of suspected sputum into the peritoneal cavity or tissues of animals constitutes a special means of diagnosis which in the past has been employed to some extent. This is attended with some inconvenience and loss of time, and is scarcely practicable in general practice. Further, the cases are exceedingly rare which demand ultimate recourse to this method. When this is actually true, however, it may happen in some cases that a precise determination of the condition is permitted long before the conclusion of the animal test. It has been found to be of great value in the midst of obscure non-progressive pulmonary conditions. The test is made by the injection of a few cubic centimeters of the suspected fluid into the peritoneal cavity of the guinea-pig, or by the introduction of the expectoration upon a sterile platinum loop into a pocket produced by the separation of the skin from the subcutaneous tissue. In either event the hair is shaved from a small area surrounding the site of the operation, which is performed under strict antiseptic precautions. The animal killed after six or eight weeks will show, in positive cases, pathologic evidences of a tuberculous infection. The unfortunate delay in securing definite information is said to have been overcome recently by injecting suspected material into the mammary glands of guinea-pigs or rabbits which are suckling their young. Experiments performed by Larier, Ronzoni, and Hirschborn have demonstrated the presence of the bacilli *in loco* after a delay of only five to ten days, owing to the favorable medium afforded for growth.

It is well to reiterate that the utility of the special aids to diagnosis is confined to relatively few cases, and that, in the majority of instances, the available evidence is amply sufficient to permit a positive conclusion. The use of some of the newer methods demands a complicated apparatus and a considerable experience. Tuberculin, the Röntgen rays, and guinea-pigs are not always within the reach of the general practitioner, and their usefulness may be safely reserved for cases exceptionally obscure. Other special methods of diagnosis have been recommended from time to time, but their use is attended with much variability in results, rendering them of but little practical value.

THE RÖNTGEN RAYS

The *beginning* deposit of tubercle is not *always* attended with sufficient consolidation to disclose, in the radiograph, evidence of structural differences. The existence of an appreciable deviation from the normal shadow presupposes an antecedent pathologic change in the pulmonary tissues. Provided there is *no* unilateral localized increase of density observed upon transillumination, this absence of asymmetric change may be assumed to indicate the non-existence of any gross

tissue abnormality. On the other hand, a structural lesion sufficient to *show* a distinct shadow change is often preceded by such subjective and objective signs as will warrant an unqualified diagnosis. The use of the fluoroscope is admittedly of some aid in afford-

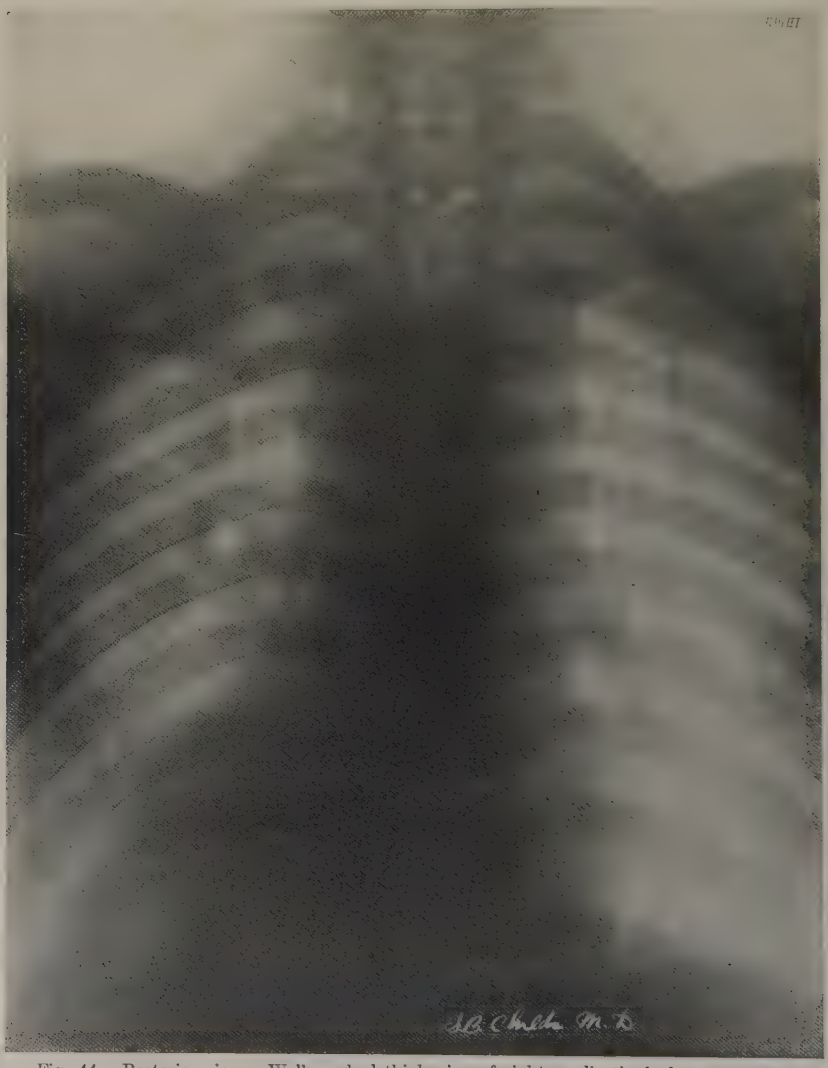


Fig. 44.—Posterior view. Well-marked thickening of right mediastinal pleura, exerting pronounced traction at right apex, shrinkage of apex as recognized by physical signs suggesting tuberculous involvement. The thickening of mediastinal pleura somewhat simulates aortic aneurysm. (Compare with Fig. 37.)

ing an opportunity to note the delayed or diminished descent of the diaphragm. This has been reported by several as characteristic of the very incipient stage of apical involvement. It may be present, however, in cases of long-standing pleural adhesions and certain abdominal conditions interfering with the movement of the diaphragm. In

such cases this sign is, of course, devoid of any special significance. I have observed a material retardation in the descent of the diaphragm upon one side, without the slightest obtainable evidence of tuberculous infection. Some have reported, as a result of transillumination, a distinct appreciation of the comparatively small size of the heart in

Fig. 45.—Posterior view. Slight tuberculous infiltration at right apex in spite of normal apical percussion outline, as shown in Fig. 6. Also marked thickening, probably glandular, at root of right lung. Heart small in size, displaced upward and to the right. Note peculiar configuration of ribs.

consumptives. While this is of clinical interest in yielding confirmatory evidence of previously entertained impressions, such recognition *per se* is insufficient to justify an assumption as to the existence of early tuberculosis. In the same way it may be added that while wonderfully accurate and valuable information may be secured as to the extent and

nature of the structural changes in advanced phthisis, this constitutes no evidence as to the *invariable* utility of the *x*-ray for diagnostic purposes in incipient cases without pronounced lesions.

One of the chief objections to the use of the Röntgen rays for intrathoracic diagnosis is the necessity of their exclusive employment by

Fig. 46.—Posterior view. Very slight thickening left apex. Moderate thickening at right apex with tuberculous infiltration extending to fourth rib. Note the peculiar curve of ribs in upper part of picture. Heart small, partially obscured, and displaced slightly to the left.

experts. Only in such hands may it be possible to secure sufficient detailed definition to permit of correct interpretations. In an effort to obtain the necessary detail the time of exposure should be as short as possible, and the chest should be at rest.

Fig. 47.—Posterior view. Slight infiltration, each apex, more pronounced on right. Thickening mediastinal pleura, with infiltration at root of each lung.

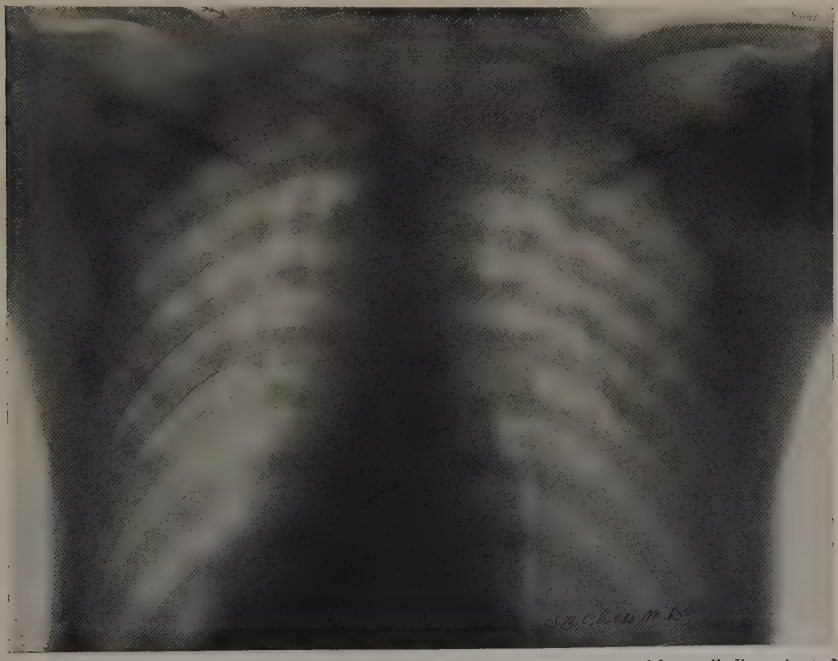


Fig. 48.—Posterior view. Slight tuberculous infiltration each apex, with small disseminated tuberculous glands in the cervical and upper mediastinal regions. Arrow indicates isolated remnants of cervical glands. (For fuller description of this case see p. 421.) Heart small and pulled upward.

During the past year, with the valued assistance of Dr. S. B. Childs, I have resorted to radiography in a large number of clearly defined cases of tuberculosis, in order to compare the clinical and skiagraphic findings. This method of diagnosis has been used to confirm, if possible,

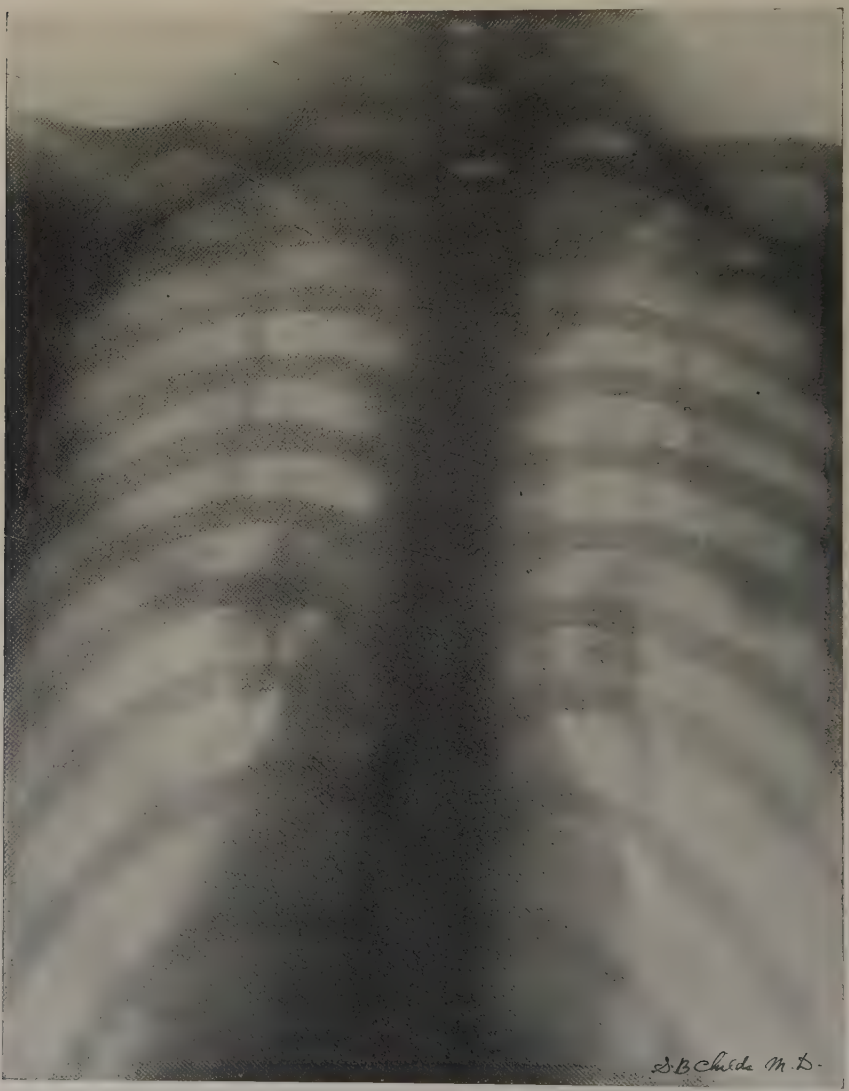


Fig. 49.—Posterior view. Well-defined tuberculous infiltration at the root of each bronchus with complete absence of physical signs, in a patient exhibiting progressive loss of weight and daily temperature elevation. Heart displaced slightly to the right.

the results of physical examination with reference to small circumscribed effusions, pulmonary cavities, and suspected mediastinal glands. As a rule, the information secured has been strikingly conclusive. As a result of this inquiry, however, previous convictions as to the slight

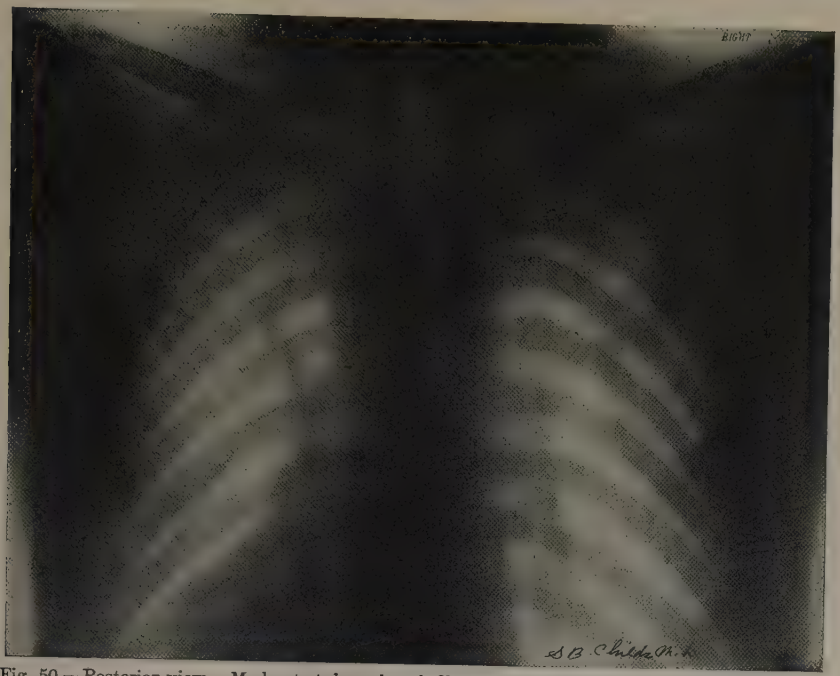


Fig. 50.—Posterior view. Moderate tuberculous infiltration each apex, more pronounced at right. Heart displaced slightly to the left.

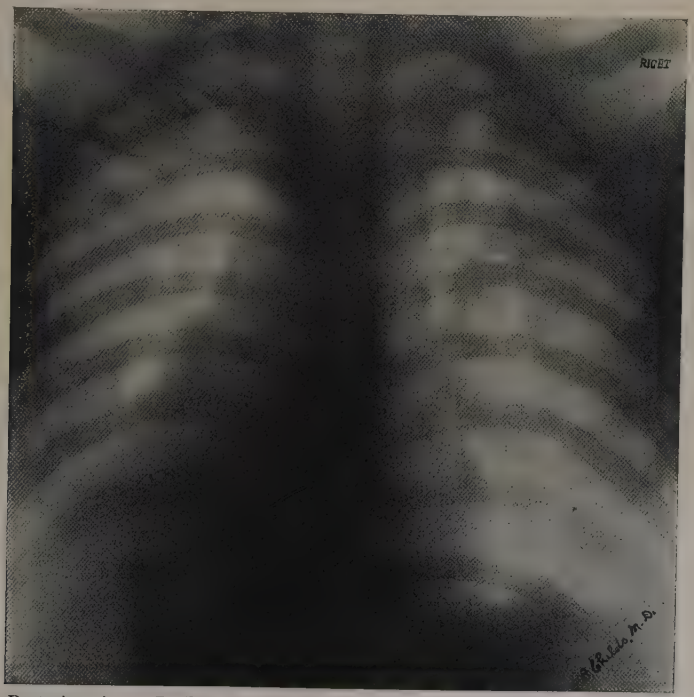


Fig. 51.—Posterior view. Peribronchial infiltration, right interscapular region, corroborative of physical signs, which consist of very fine clicks at end of inspiration following a cough.

practical value of the *x*-ray in the diagnosis of *very incipient* cases without well-defined structural lesions, have been substantially confirmed. Though transillumination of the chest has not been found to be of great utility for the purposes of early diagnosis, save in exceptional cases, it has afforded in some advanced stages information of a

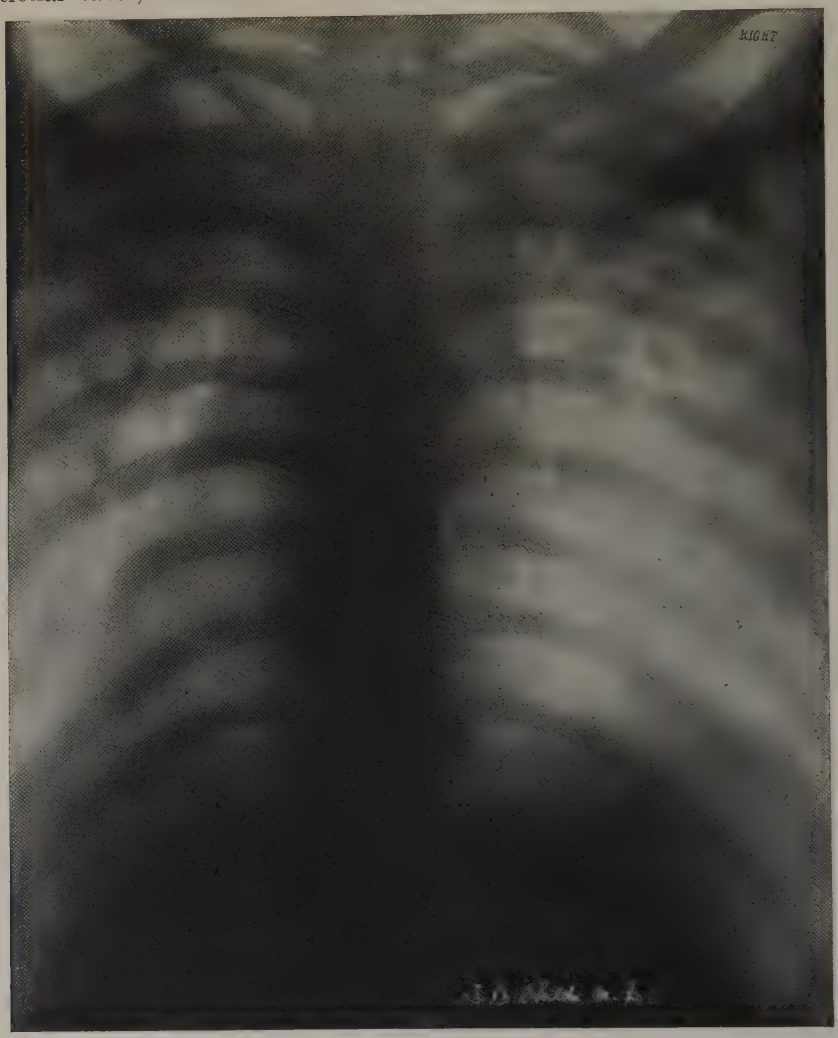


Fig. 52.—Posterior view. Moderate tuberculous infiltration, both lungs, slightly more marked at left apex. Thickening of mediastinal pleura. Heart small, partially obscured, and displaced upward.

highly important nature. Decided value has attached to its employment corroborative of, or supplementary to, the results of physical examination. It is of some interest to note that several cases of slight but undoubted infection, upon the basis of physical signs, were found to exhibit no appreciable shadow variation. Upon the other hand, although the physical examination in some instances disclosed signs

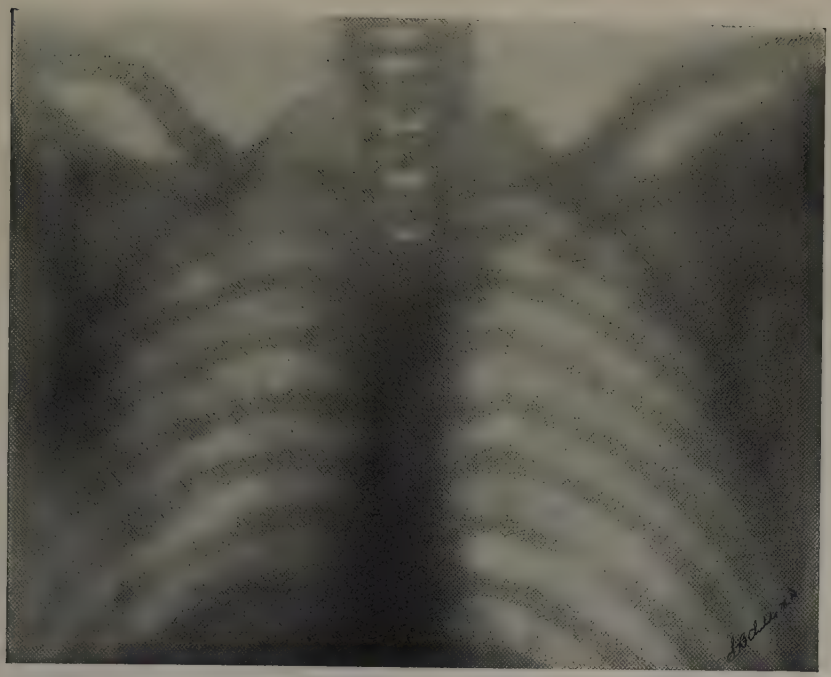


Fig. 53.—Posterior view. Widely disseminated tuberculous infection of the left lung, without apical involvement. Note peculiar mottled appearance, suggesting possible miliary infection. This case is of interest in view of the uniform absence of shadow at the apices, despite disparity in the percussion outlines, as shown in Fig. 39.

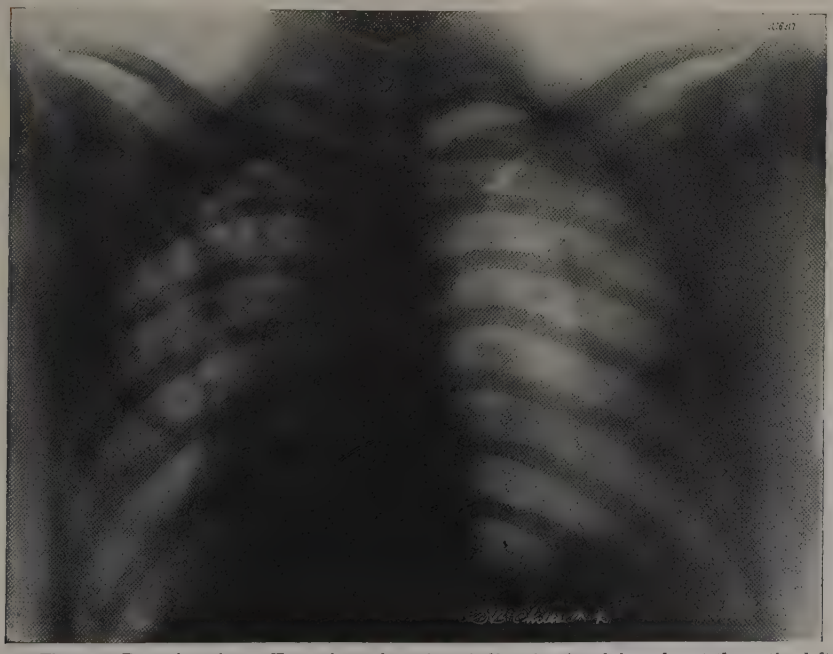


Fig. 54.—Posterior view. Extensive tuberculous infiltration involving almost the entire left lung. Note peculiar mottling in scapular region. Slight involvement at right apex and at root of right lung. Physical signs denote cavity in left upper lung, as suggested in the radiograph. Compare with Fig. 13, page 163.

of an exceedingly definite character, apparently permitting conclusive interpretations, the radiograph revealed a surprising divergence from the clinical findings. The lack of correspondence between the results of the physical and *x*-ray examinations related particularly to the

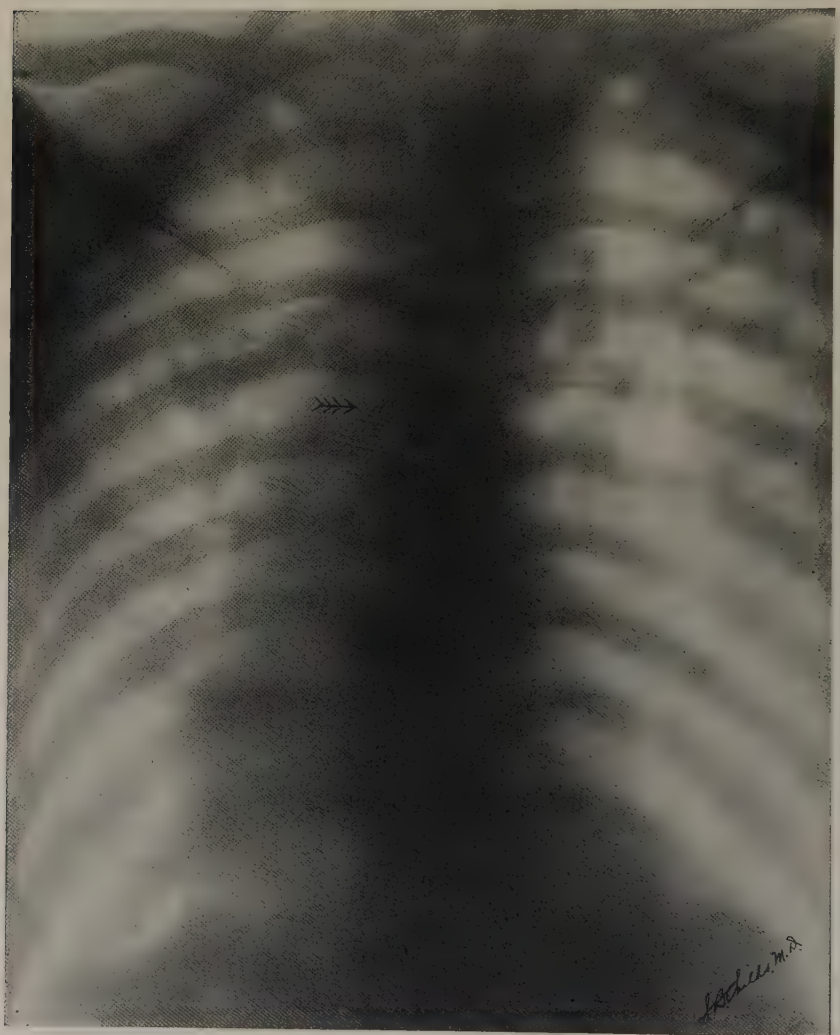


Fig. 55.—Posterior view. Moderate tuberculous infiltration of both apices. Cavity size of egg at right apex. Well-defined thickening of mediastinal pleura extending above clavicles, with greatest breadth at level of clavicle. Tuberculous gland at junction of sixth rib with vertebra, as indicated by arrow. Heart small, partially obscured, and displaced upward.

determination of the size and position of the heart, the diagnosis of pulmonary cavities, and the detection of bronchial glands.

Slight and even moderate cardiac displacement from the traction incident to fibrous tissue proliferation was found in several cases, when such condition was not suggested upon physical examination. This was especially true of upward displacement resulting from marked

fibrosis of the mediastinal pleura. It is well understood that certain difficulties in the way of accurate physical diagnosis are incident to the anatomic location of a considerable portion of the heart beneath and to the right of the sternum, and to its frequent denudation upon

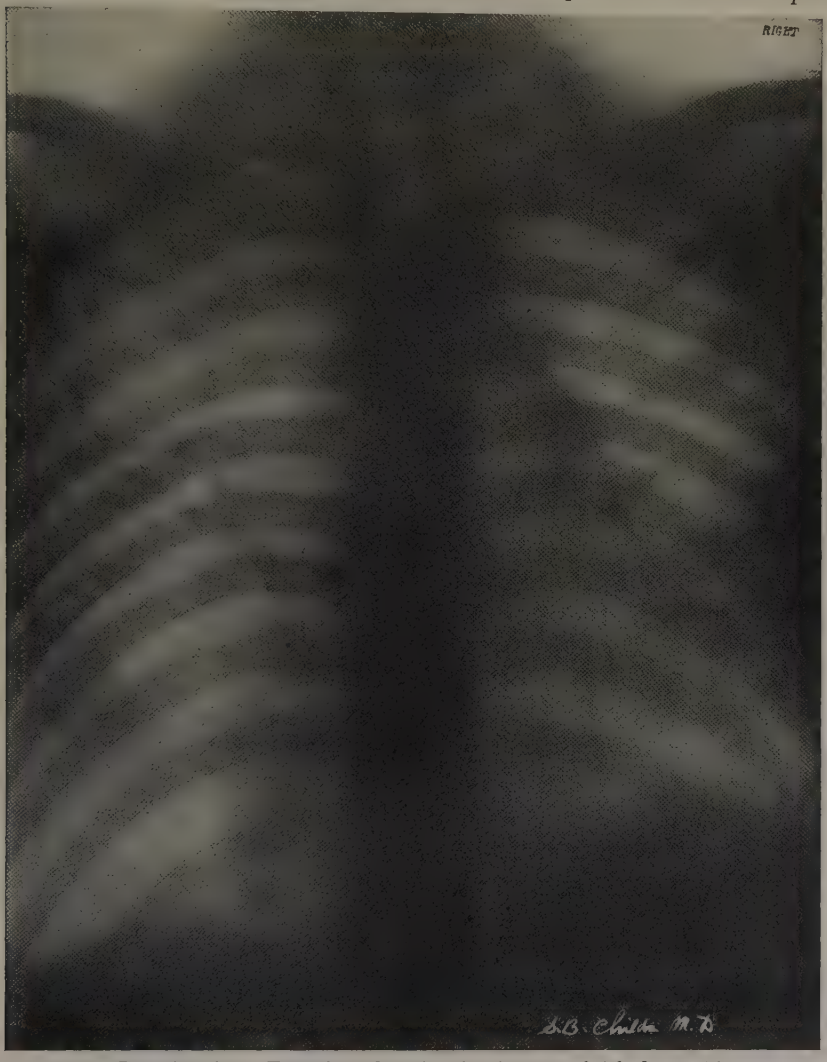


Fig. 56.—Posterior view. Extensive tuberculous involvement of right base, with connective-tissue contractile change. Note height to which diaphragm ascends on right side, as compared with left. Slight involvement of right apex. Slight tuberculous infiltration, left upper lung. Note circumscribed area simulating cavity. Heart small, partially obscured, and displaced to right. Compare with Fig. 102.

the left side by pulmonary shrinkage. This often increases the area of cardiac dulness in tuberculous patients to a very material extent. Several times I have experienced the utmost difficulty without the aid of the *x*-ray in determining with precision between a displaced and a dilated or hypertrophied organ. The obstacles in the way of a correct

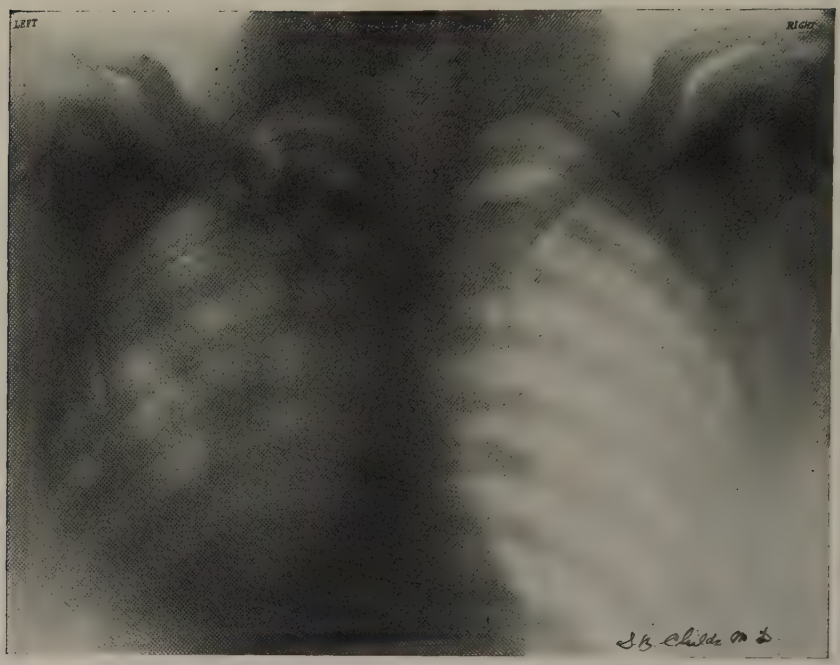


Fig. 57.—Posterior view. Extensive tuberculous involvement, entire left lung, in negro. Process has undergone complete arrest. Compare with Fig. 93.

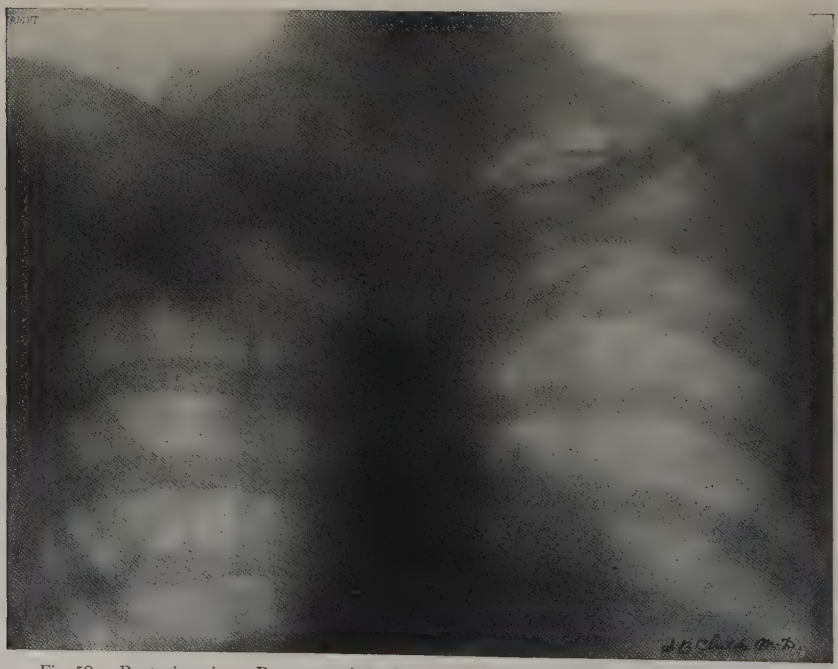


Fig. 58.—Posterior view. Pronounced thickening of mediastinal pleura, with infiltration of right apex. Physical signs strongly suggestive of pulmonary cavity. Second and third ribs on the right previously resected in order to permit collapse of cavity. No cavity discoverable in picture. Compare with Fig. 169.

differentiation between simple displacement, among consumptives, and changes in size incident to adherent pericardium and other causes, are enhanced by the morbid pulmonary change sometimes present in immediate contiguity to the heart itself, often obscuring the results

Fig. 59.—Posterior view. Well-marked infiltration of right lung, particularly pronounced at the root. Also infiltration of the left lung at the same level, with marked thickening above the base of the heart.

of percussion. In such cases the use of the *x*-ray has been shown to be of inestimable value as an aid to diagnosis. Short exposures are necessary for the accurate study of the heart, otherwise, on account of the cardiac pulsation, there is lost a sharp definition of outline. Very short exposures of from one-half to one-fifth of a second, however, are

rarely attended by satisfactory results, save in little children or much emaciated adults. Perfect sharpness of outline is not indispensable in the determination of the size and position of the heart. Moderately long exposures of from five to twenty seconds in duration, while pro-

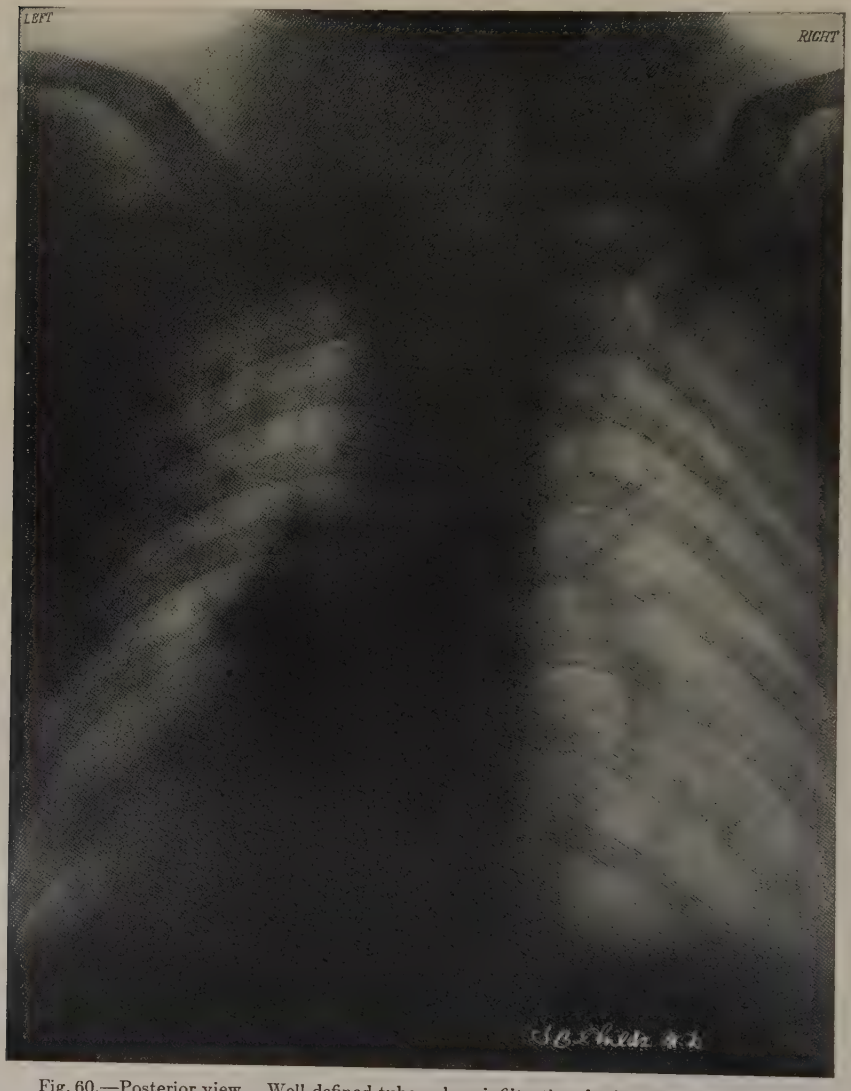


Fig. 60.—Posterior view. Well-defined tuberculous infiltration, both apices, more marked on the left. Pronounced thickening, mediastinal pleura and peribronchial infiltration. Also thickening of left base. Physical signs show moisture left side, apex to base.

ducing a less clear definition of the cardiac boundary, are occasionally required, especially in well-nourished individuals and in those of considerable muscular development. A hazy outline similar to that of a composite photograph is sometimes unavoidable in skiagraphs of

the heart on account of its movement, and although less satisfying from an artistic point of view, is none the less valuable in a study of the size and position. The position of the heart is further considered in connection with displacement of organs as a result of pleuritic contraction change. (See p. 358.)

Fig. 61.—Posterior view. Extensive tuberculous infiltration of both apices on the right, to the ninth rib, and on the left, to the sixth. Heart small, partially obscured, pulled upward and to the right. Notice higher level of diaphragm on left side.

The employment of the *x*-ray has been of some interest in the clinical study of pulmonary excavation. While but few cavities have appeared in the skiagraphs which had not been previously detected, several were noted by the physical signs which subsequently failed to

materialize in the *x*-ray picture. This lack of verification constituted a conspicuous feature of some cases in which a diagnosis of pulmonary excavation seemed to have been irrefutable. In each case error in the interpretation of the physical signs was occasioned by the existence of

Fig. 62.—Posterior view. Extensive tuberculous infiltration, right lung, from second rib to base, posteriorly. As result of well-defined contractile change diaphragm pulled upward and heart of small size and partially obscured, displaced upward and to right. Tuberculous infiltration of left lung, from apex to sixth rib, posteriorly. Note mottling in both lungs. Cavity left upper back. Compare with Fig. 101.

a localized area of consolidation directly over a primary bronchus. In one case a similar diagnosis of pulmonary cavity had been made previously by three clinicians of unusual skill in conducting physical examinations.

Bronchial glands were depicted prominently in a few pictures after a diagnosis had been made upon the basis of the physical signs and pressure symptoms. More frequently, however, they were found in the skiagraph when their presence had not been anticipated.

Upon the other hand, the *x*-ray picture occasionally simulated certain pathologic conditions which, in fact, did not exist, notably aortic aneurysm and pleural effusion. As these conditions were assuredly absent upon the basis of the physical evidences, it follows that the skiagraphic findings *per se* are sometimes susceptible of erroneous

Fig. 63.—Posterior view. Extensive tuberculous involvement, entire left lung, with moderate infection at right apex. Pronounced connective-tissue contraction change in left lung, with marked pleural thickening. Heart small, partially obscured, and displaced noticeably to the left. Small cavities between third and fourth and fifth and sixth ribs. Compare with Fig. 97.

construction save by an expert interpreter. The suggestion of aneurysm was occasioned by enormous hypertrophy of mediastinal pleura, and the simulation of pleural effusion, by excessive thickening and contraction of the pleura. As a result of this comparison of the clinical and *x*-ray evidences of pulmonary tuberculosis, the conclusion has been forced that valuable supplementary information is offered by radiography, in cases exhibiting definite structural change, but that its *most important* diagnostic scope is limited to such conditions. A considerable number of interesting reproductions are presented in order to illustrate this position.

It is worthy of note, however, that in a few exceptional cases the employment of the *x*-ray was of signal advantage as an aid to the early diagnosis when the physical findings admitted of reasonable doubt.

It should be understood that, in submitting the following radio-

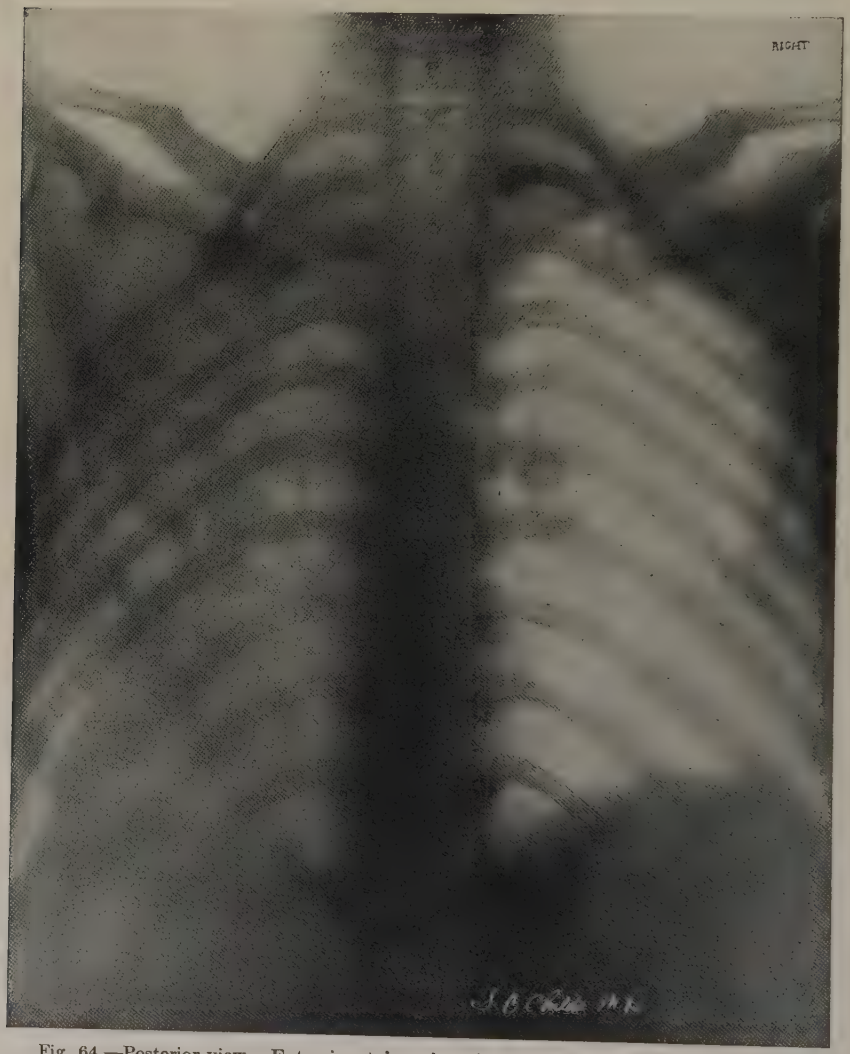


Fig. 64.—Posterior view. Extensive tuberculous infiltration, entire left lung. Slight infiltration, right apex. Well-defined mediastinal gland at root of right lung. Heart small, partially obscured, and displaced to left.

graphs, the plates are selected almost entirely with reference to their relation to the results of physical examination. It is designed to present the *x*-ray findings of a few patients, in whom the diagnosis was more or less obscure, upon the basis of the physical exploration of the chest. In addition, there are exhibited radiographs of individuals

displaying well-defined physical evidences of active and extensive tuberculous infection. The patients comprising the series of cases, as represented by the radiographs, do not conform to any fixed type of pulmonary tuberculosis, the physical signs denoting a varying degree

Fig. 65.—Posterior view. Tuberculous infiltration, entire left lung, with pronounced pleural thickening at base. Note mottling in scapular region. Heart small, partially obscured, and displaced to left. Slight infiltration, root of right lung. Cavity in left upper back.

and character of pulmonary involvement. Thus will be seen, from an *x*-ray standpoint, the different pathologic changes in pulmonary tuberculosis, from the very incipiency of the disease to the advanced stages.

The pathologic processes shown upon *x*-ray examination consist of slight apical infiltration, moderate tuberculous consolidation, localized

...extensive, wide-spread areas of tuberculous consolidation, sometimes involving an entire lung and parts of the other, differing degrees of pulmonary emphysema, diffused tubercle deposit in miliary tuberculosis,

Fig. 99.—Roentgen picture. Very extensive tuberculous infiltration of left lung, with well-marked ... displacing the heart upward and to the left. Note the dark shadow occasioned ... Well-marked circumscribed tuberculous patches ... Note absence of heart shadow in front ... small size. Compare with Fig. 98.

...well-marked thickening of mediastinal pleura, often simulating aneurysm, ... enlargement of tracheobronchial glands, contractile changes ... fibrous tissue proliferation, resulting upward and lateral ... of the heart, the frequent small size of this organ, the

imperfect descent of the diaphragm upon one side, marked unilateral pleuritic thickening simulating effusion, small and moderate pleural effusions, the density of the shadow corresponding with the curved lines of percussion dulness, localized empyema, pneumopyothorax, and other processes of a non-tuberculous nature, though of diagnostic interest in connection with pulmonary phthisis.

The *occasional* utility of the *x*-ray as an aid to the early diagnosis of pulmonary tuberculosis is well illustrated in Fig. 45, which shows a pronounced tuberculous infiltration at the right apex, although the apical percussion outline is entirely normal, as shown in Fig. 6. Careful

Fig. 67.—Posterior view. Enormous tuberculous infiltration, with extensive pleural thickening, entire left lung. Cavity in front of the spine of the scapula below anterior end of first rib corroborated by physical signs. Heart obscured, but pulled to the left.

auscultation also fails to disclose the slightest evidence of tuberculous infection.

In connection with the preceding case, the radiograph, Fig. 44, is of especial interest. In this instance, the physical signs suggest a possible tubercle deposit at the right apex. There is an appreciable shrinkage of the air-content in this region, as shown by the percussion boundaries represented in Fig. 37. Upon *x*-ray examination there is found no evidence of tubercle deposit at either apex. A thickening of the right mediastinal pleura had exerted sufficient traction at the right apex to afford a reasonable suspicion of shrinkage from tuberculous infection.

In the radiograph, Fig. 53, is shown a tuberculous infiltration

involving almost the entire left lung. While the auscultatory evidences are well defined in this area, there is also an appreciable shrinkage in the percussion boundaries at the right apex. The *absence* of shadow change in the latter region is, therefore, possessed of considerable clinical interest. Upon the other hand, the apical shrinkage seen in Fig. 41 is amply explained by the destructive change represented in the radiograph, Fig. 56.

In Fig. 46 the skiagraph discloses clearly the presence of a slight thickening at the left apex, with moderate tuberculous involvement at the right, extending nearly to the fourth rib, yet the physical signs in

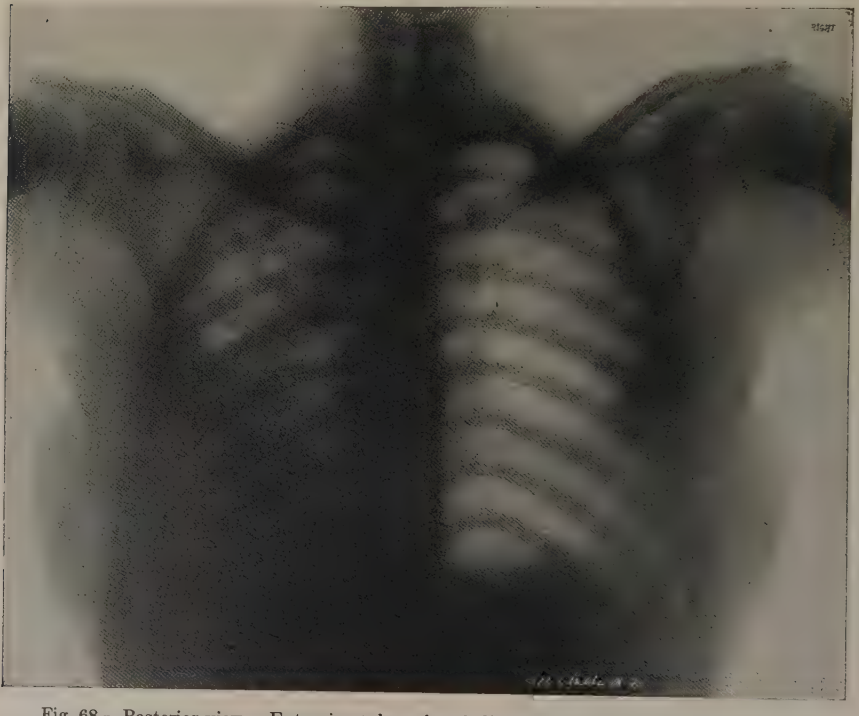


Fig. 68.—Posterior view. Extensive tuberculous infiltration, entire left lung, with pronounced pleural thickening at base. Mottling in left scapular region. Slight opacity at right apex. Heart small, obscured, and displaced to left.

this case are entirely negative. The small size of the heart in this case is worthy of note.

By reference to Fig. 47 it will be seen that the results of *x*-ray examination disclose a slight tuberculous process at each apex, somewhat more pronounced upon the right, with an appreciable infiltration at the root of each lung, yet in this case, as in the preceding, the physical signs afford no suggestion of tubercle deposit.

Fig. 49 is also of much interest in connection with the early diagnosis of pulmonary tuberculosis. The patient had displayed for several months a continuous loss of weight. There were daily temperature elevations, rapid pulse, and general prostration. There was no cough or

expectoration, and the physical examination was absolutely negative, yet the radiograph shows an apparent tuberculous infiltration at the root of each bronchus.

Fig. 69.—Posterior view. Extensive connective-tissue contraction, with pronounced pleural thickening throughout entire left lung. Note lateral curvature of spine incident to traction. Heart displaced markedly to left and partially obscured by pleural thickening. This case is of especial interest in view of the fact that the patient has secured a remarkable arrest of the tuberculous process, with entire absence of tubercle bacilli.

In Fig. 50 the radiograph represents the existence of a localized tuberculous infection at each apex, somewhat more pronounced upon the right side. The physical signs in this case at the time of examination

admitted of reasonable doubt in their interpretation, although some months previously moisture was recognized at each apex.

Evidence of slight tuberculous infiltration at each apex is seen by

Fig. 70.—Posterior view. Extensive infiltration of entire right lung. Moderate infiltration of left. Heart small and displaced to right. Several small cavities on right side and bronchial glands on left. Condition at base of right lung somewhat obscure. Marked shadow at right base, suggesting pleural effusion, in corroboration of physical signs. Negative result from half-dozen aspirations.

reference to the radiograph, Fig. 48. Tuberculous cervical glands were readily palpable. Upon each side there was pronounced dulness upon percussion, and the respiratory sounds were appreciably enfeebled.

The results of x-ray examination, as shown in Fig. 51, are strikingly corroborative of the physical signs. In the radiograph is shown a slight tuberculous deposit in the right middle and upper back. The

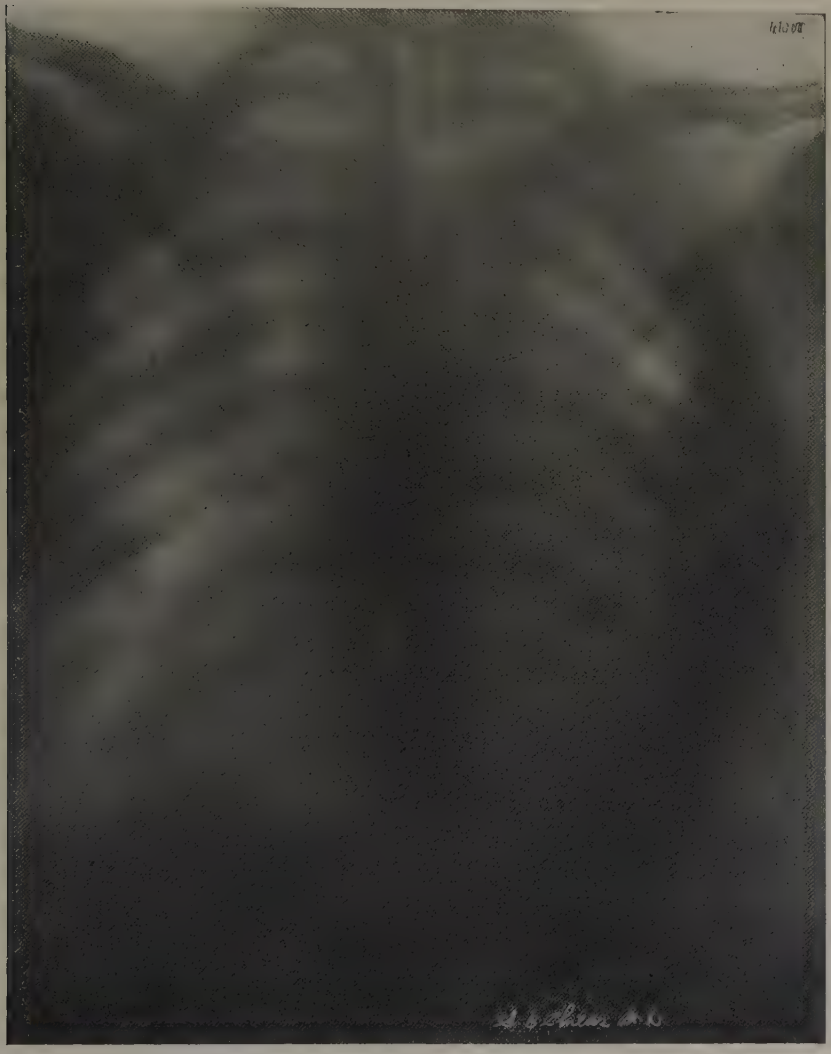


Fig. 71.—Posterior view. Extensive tuberculous involvement, both lungs. Note the comparatively slight change at apices and the extensive pleural thickening at right base. Cavity in right lung between fourth and fifth ribs and well-defined infiltration, left lung, in the neighborhood of the fifth and sixth ribs. Note marked pleural thickening at left base. The physical signs in right back strongly suggested pleural effusion, but negative results were obtained from numerous aspirations. Heart apparently small, partially obscured, and displaced to the right.

physical signs, as indicated in Fig. 36, relate purely to the presence of very fine clicks in the right upper interscapular space at the end of inspiration following a cough.

It is apparent, from the preceding cases, that the *x*-ray may occasionally be of service in the detection of small localized areas of quiescent or arrested tuberculous infection. This is especially true

Fig. 72.—Posterior view. Pleural effusion, right base. Extensive tuberculous involvement, upper right lung. Large cavity, right lung, fifth to seventh ribs. Tuberculous infiltration, entire left lung. Heart obscured.

when an incipient tuberculous process limited to one apex is unassociated with fine clicks or well-defined modifications of the normal respiratory sounds.

Among the cases with more pronounced tuberculous involvement

there was no difficulty experienced in establishing a diagnosis from the physical examination. In many cases, however, the information yielded by the skiagraph as to the extent and nature of the involvement was of considerable value. As previously stated, this related especially

Fig. 73.—Posterior view. Case of moderate pleural effusion, left lung. Characteristic letter of "S" curve, extending to the inferior angle of the scapula, in direct corroboration of physical signs.

to the detection of slight degrees of cardiac displacement unrecognized upon physical examination.

In addition to the cardiac displacement from traction exerted by virtue of fibrous tissue proliferation, the enormous thickening of medias-

tinal pleura has been of much interest in many cases. The lack of parallelism between the physical and radiographic findings, with reference to pulmonary cavities, has already been cited.

The frequency of the conspicuous enlargement of tracheobronchial

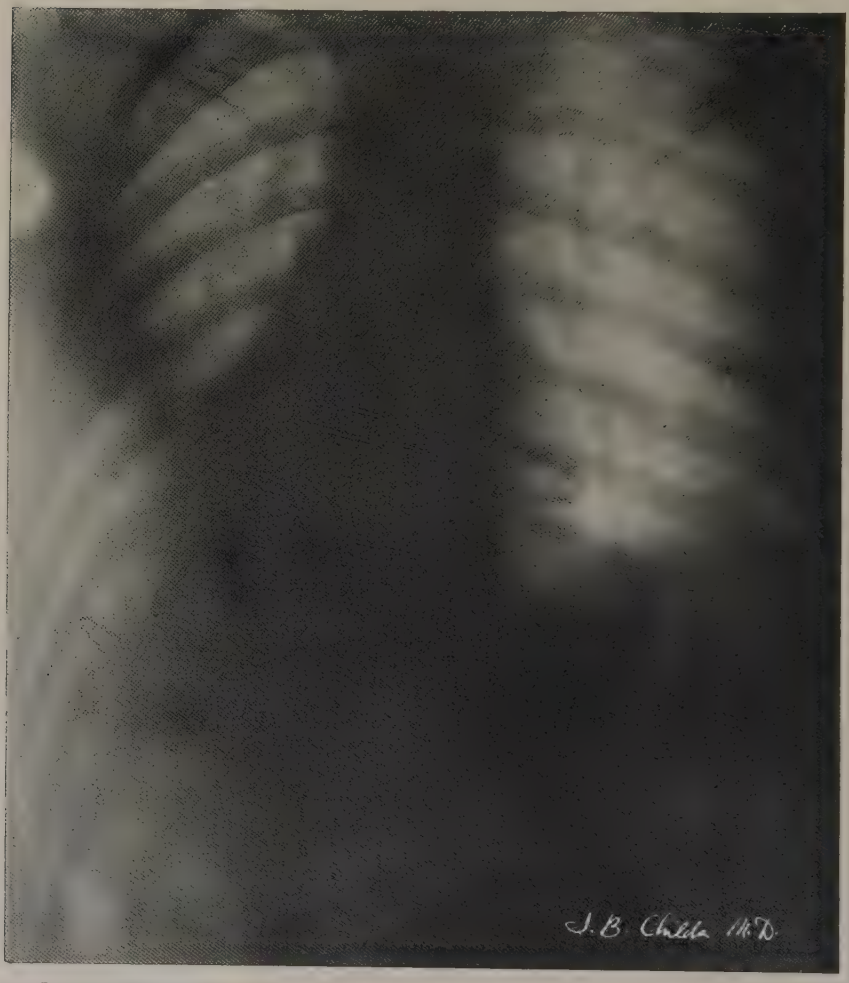


Fig. 74.—Posterior view. Case of localized empyema of left lung three weeks after operation. Skiagraph taken through dressings, showing drainage-tube *in situ*. Heart small and partially obscured. Compare with Fig. 106.

glands, when unsuspected upon physical examination, is also worthy of note.

In addition to these general considerations, to which attention has been called, it is perhaps well to analyze a few features in some detail.

The radiograph discloses the existence of tuberculous infiltration in both lungs in 28 out of a total of 37 cases of pronounced pulmonary infection. In 9 instances the infection of the lesser involved lung

was not noted upon physical examination, although the more extensive processes in the other were readily detected. In these cases small areas of tuberculous infiltration are shown in the radiograph, either at the apex or at the root of one lung.

Fig. 75.—Posterior view. Case of old pneumopyothorax two years after Schede operation. Cavity injected with three and one-half ounces of bismuth solution. Note retraction of right side and unilateral curvature of spine. Heart obscured. Compare with Figs. 107, 108, 109.

Among the non-tuberculous cases, numbering 10, 3 are instances of extensive thickening of mediastinal pleura, of which the radiograph in 1 case simulated the appearance of aneurysm to a striking degree. One shows clearly the characteristic letter "S" curve in pleural

effusion, 2 are cases of circumscribed pneumothorax, 2 of pneumopyothorax, 1 represents the pathologic change in carcinoma of the mediastinum and lung, and 1, in abscess of right lung following pneumonia.

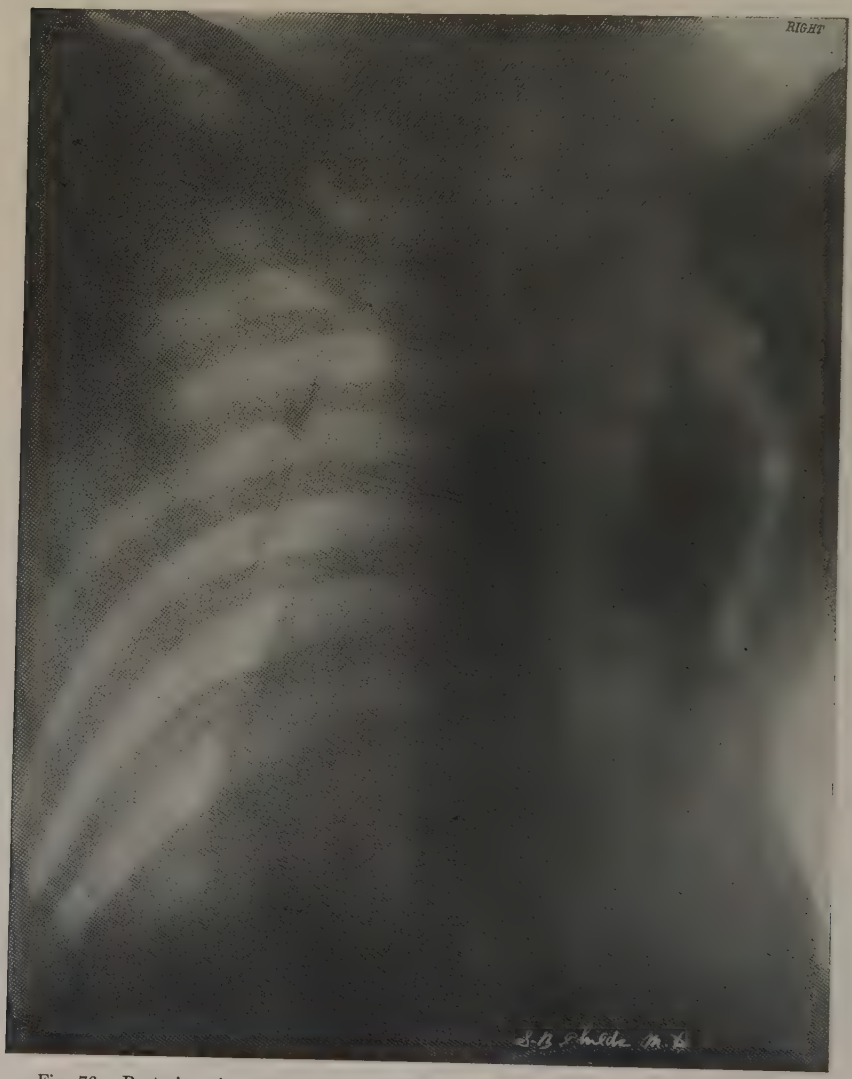


Fig. 76.—Posterior view. Same case as Fig. 74. Pneumothorax three years after Schede operation. Cavity injected with one and one-half ounces of bismuth solution. Note small size of cavity in comparison with Fig. 75. Heart obscured.

In the distinctly tuberculous cases the mediastinal pleura is greatly thickened in 19, the simulation of aneurysm being pronounced in 5. In the radiographs taken from cases of carcinoma of the mediastinal pleura and abscess of the lung respectively, the resemblance to aneurysm is especially marked.

Extensive unilateral thickening of the pleura is found in 18 instances. Of these, the possibility of pleural effusion is suggested by the radiographic findings in 8 cases.

A pronounced disparity with reference to the height of the diaphragm upon the two sides is noted in 8 cases.

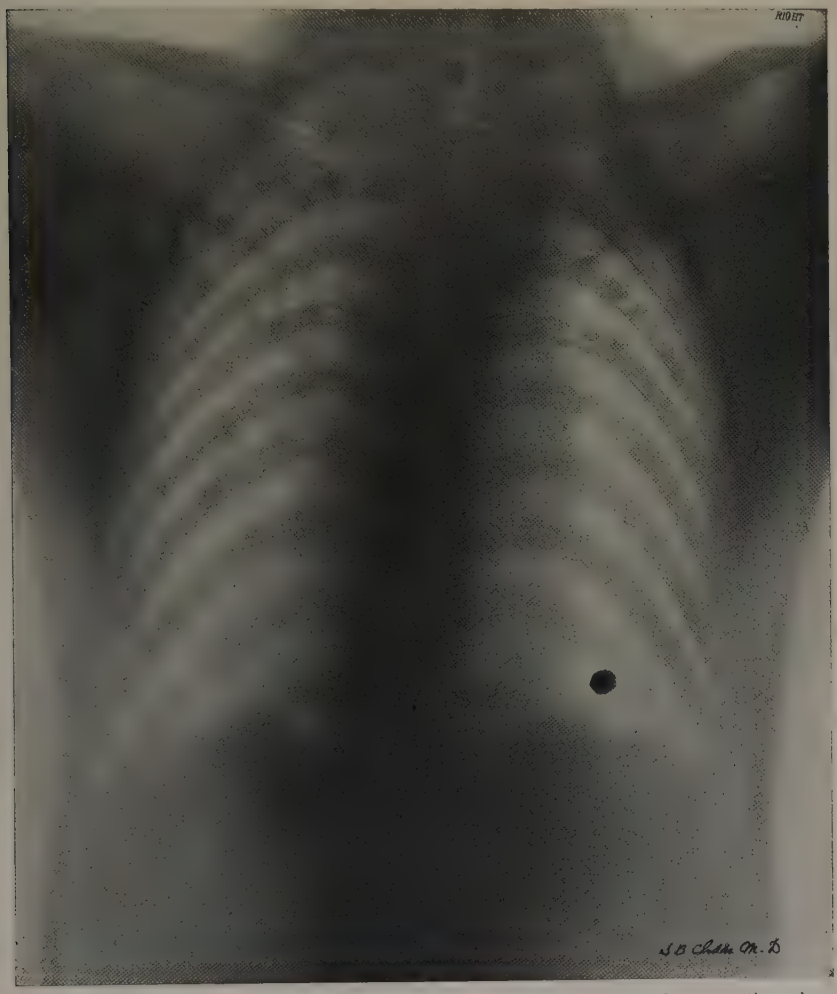


Fig. 77.—Posterior view. Case of circumscribed empyema ten years after operation, showing resection of tenth rib. Small dark spot in right base is the shadow of a piece of lead indicating the middle of the cicatrix. Slight infiltration, upper portion of each lung, especially pronounced at the right. Thickening of mediastinal pleura. Pulling of heart upward and to the right. Heart of small size. Compare with Fig. 105.

The heart is apparently of small size in 20 instances. It is partially or entirely obscured in 17, while in the remaining cases no deviation from the normal size is suggested. As a result of the traction incident to fibrous tissue change the heart is displaced to the right in 9 cases,

to the left in 10, upward in 6, upward and to the right in 5, upward and to the left in 1, making a total of 31 instances of cardiac displacement.

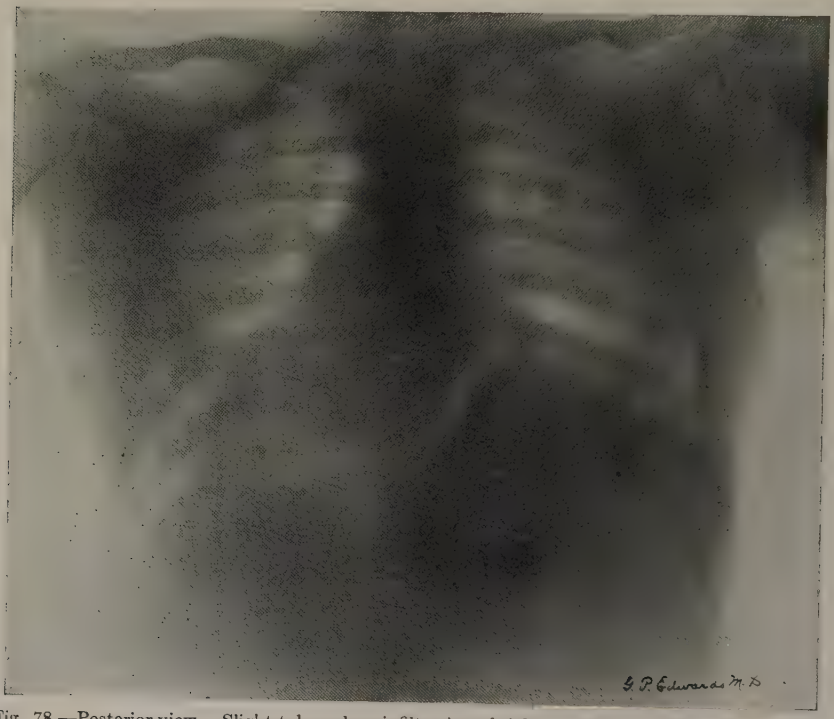


Fig. 78.—Posterior view. Slight tuberculous infiltration of right upper lung, with marked consolidation and pleural thickening at right base. Compare with Fig. 104.

Pulmonary cavities are shown in 13 cases, and perceptible enlargement of tracheobronchial glands in 10.

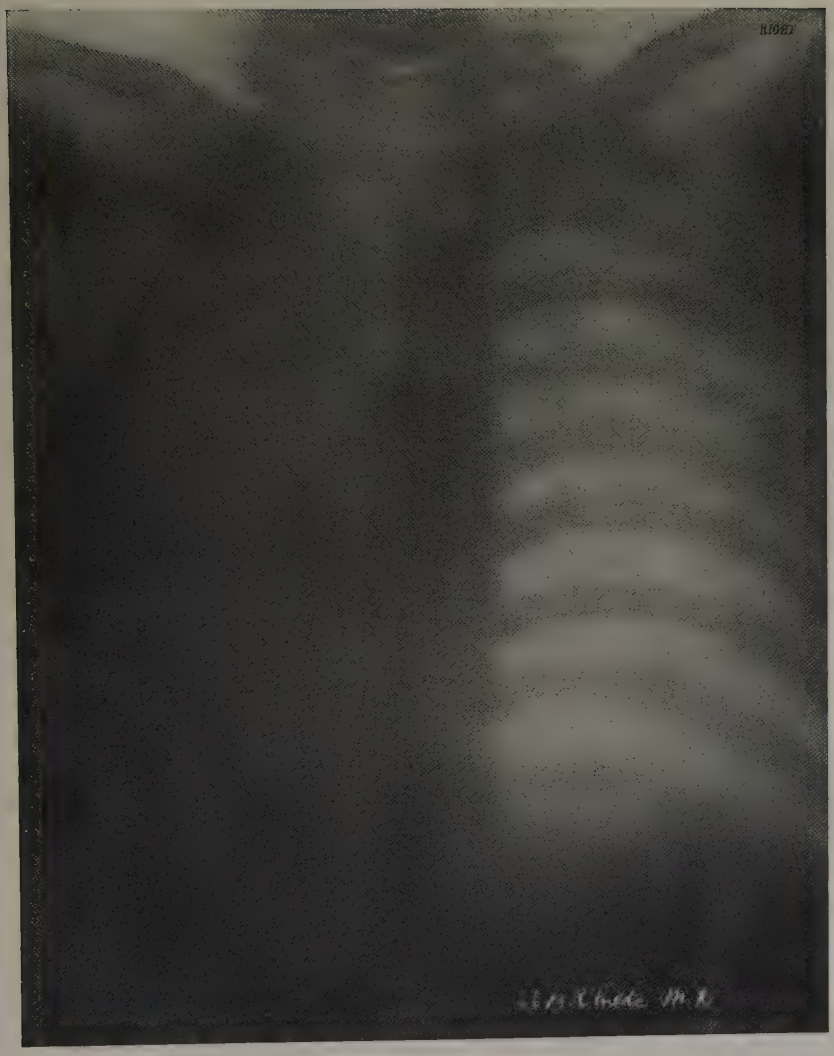


Fig. 79.—Posterior view. Very extensive tuberculous infiltration, entire left lung, with marked pleural thickening at base. Note the lateral spinal curvature incident to fibrous tissue contractile changes. Moderate tuberculous infiltration, right upper lung. Heart of small size, partially obscured, and displaced to the left. Compare with Fig. 42.

Fig. 80.—Posterior view. Slight thickening, right apex, undoubtedly incident to previous tuberculous involvement. Slight mottling of left lung, denoting probable antecedent tuberculous infection. Well-defined pleural thickening at left base, corroborating physical signs. Heart displaced slightly to the right.

Fig. 81.—Posterior view. Moderate tuberculous infiltration, right apex, with a small and large cavity. Slight infiltration, left apex. Thickening at root of left lung. Heart of small size. Well-marked thickening of mediastinal pleura simulating aneurysm.

Fig. 82.—Posterior view. Well-marked thickening of mediastinal pleura, closely simulating aortic aneurysm. Heart small, displaced upward and to right (courtesy of Dr. Arneill).

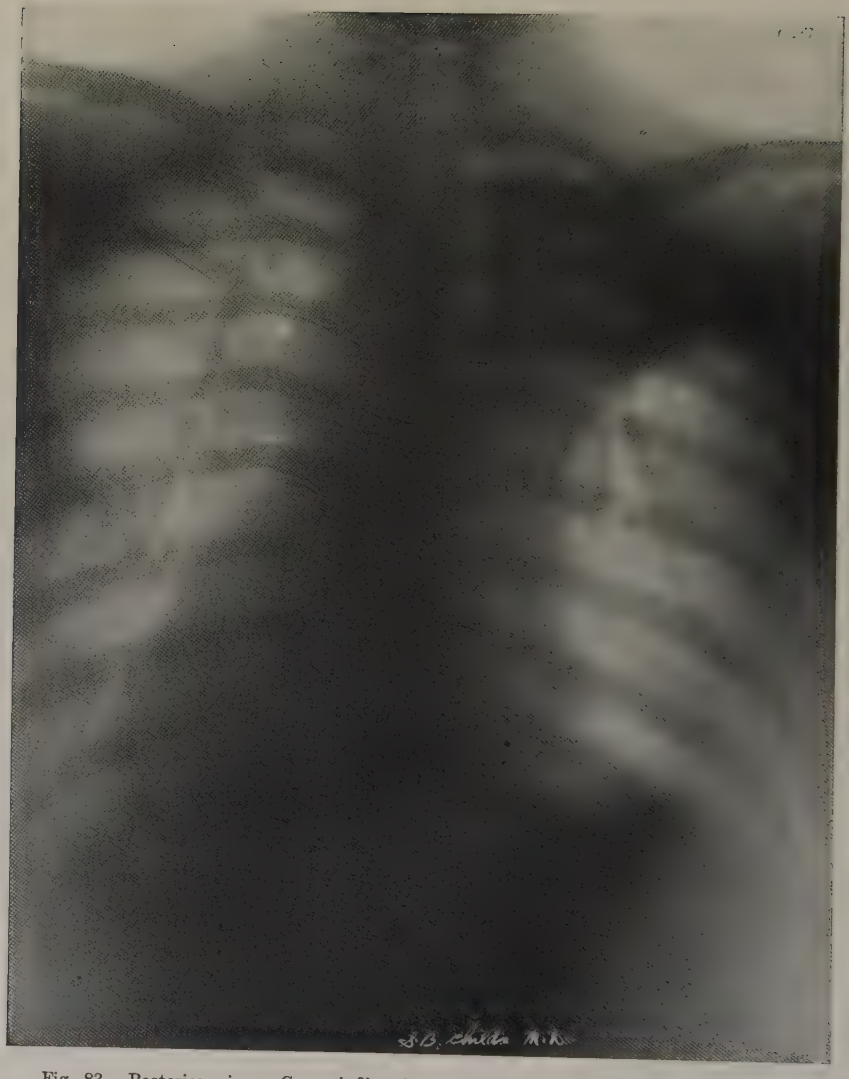


Fig. 83.—Posterior view. Gross infiltration at right apex, with thickening of mediastinal pleura, simulating aneurysm. Slight tuberculous opacity at left apex, with some thickening at root of both lungs. Heart displaced a little to the right. Partial obliteration of cavity at right apex.

Fig. 84.—Posterior view. Well-marked fibrosis of mediastinal pleura, simulating aneurysm. Large cavity on the right, behind, above, and below clavicle, inclosed by fibrous tissue band which moves very definitely on respiration, as disclosed by the fluoroscope. Heart small, partially obscured, displaced upward and to the left. A complete cervical rib on right, rudimentary on left (courtesy of Dr. Sewall).

Fig. 85.—Posterior view. Infiltration of each apex. Well-defined thickening, mediastinal pleura, markedly simulating aneurysm. Large circular pulmonary cavity in right upper region. Characteristic mottling from tuberculous infiltration on both sides. Heart small and displaced upward.

Fig. 86.—Posterior view. Extensive carcinomatous infiltration of mediastinum, very closely simulating aneurysm. Diffused glandular involvement in both lungs, secondary to primary involvement of the left breast, which was completely excised two years ago. Evidences of advanced infiltration in the lung are corroborative of physical signs. A visible palpable mass, recognized as per photograph (Fig. 25), over the upper part of the sternum. Heart obscured, displaced upward and to the right.

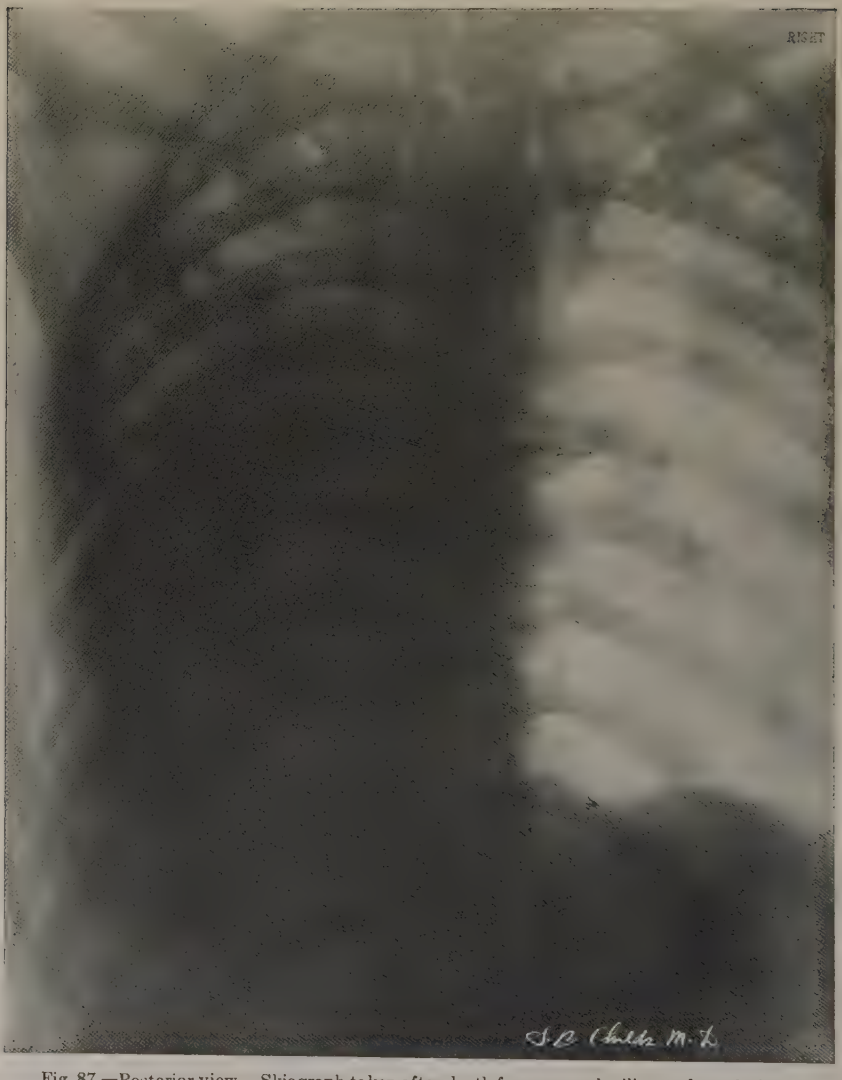


Fig. 87.—Posterior view. Skiagraph taken after death from general miliary tuberculosis complicating pulmonary phthisis. Extensive tuberculous infiltration with pleural thickening of left side. Heart small, obscured, pulled materially to left. This picture is of especial interest as showing well-defined miliary deposit in right lung, unobscured by thickened pleura.

Fig. 88.—Posterior view. Pronounced fibrous tissue proliferation of right lung, producing marked displacement of heart to right. Slight destruction of pulmonary tissue, as shown by cavity, best marked between sixth and seventh ribs. Moderate infiltration at root of left lung. (This condition is more fully described in text, see p. 296.) Heart of small size.

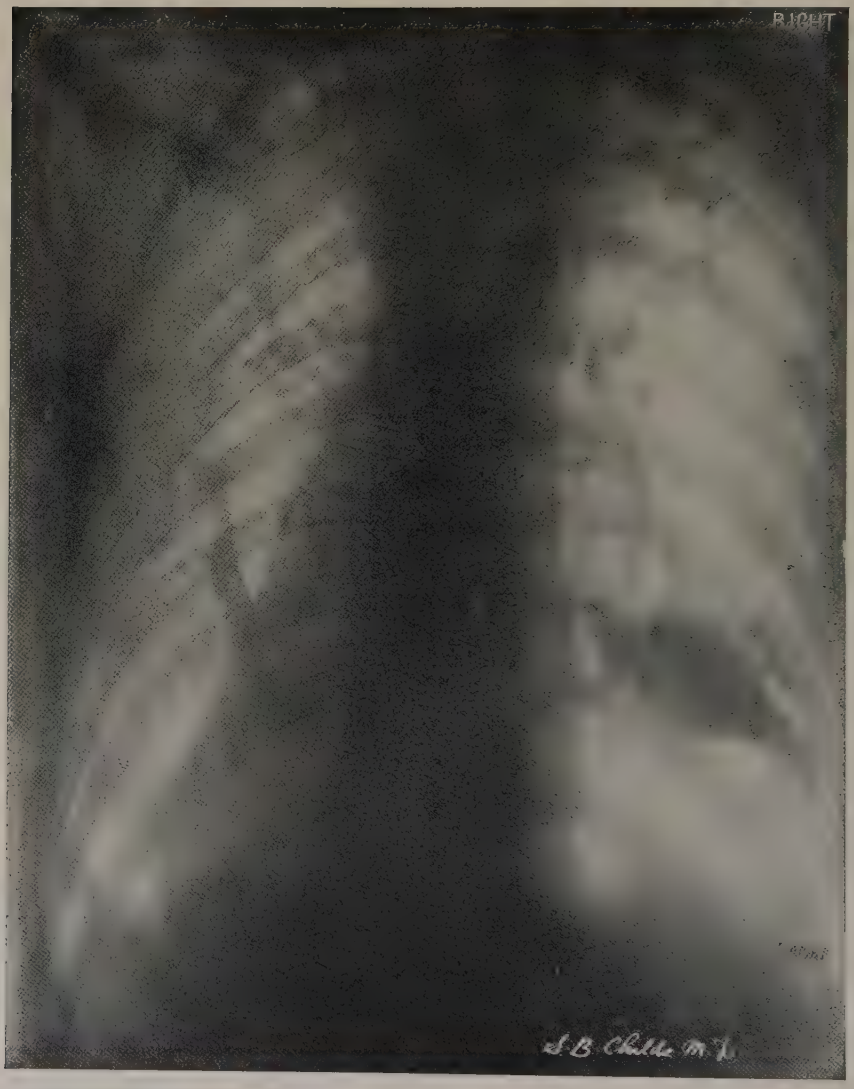


Fig. 89.—Posterior view. Thickening of mediastinal pleura, with heart dislocated upward. Slight infiltration in right upper lung. Two well-marked glands at root of right bronchus. This picture is of interest by virtue of anomalous shadows upon each side, incapable of interpretation by physical signs or by *x*-ray appearance. Heart of small size.

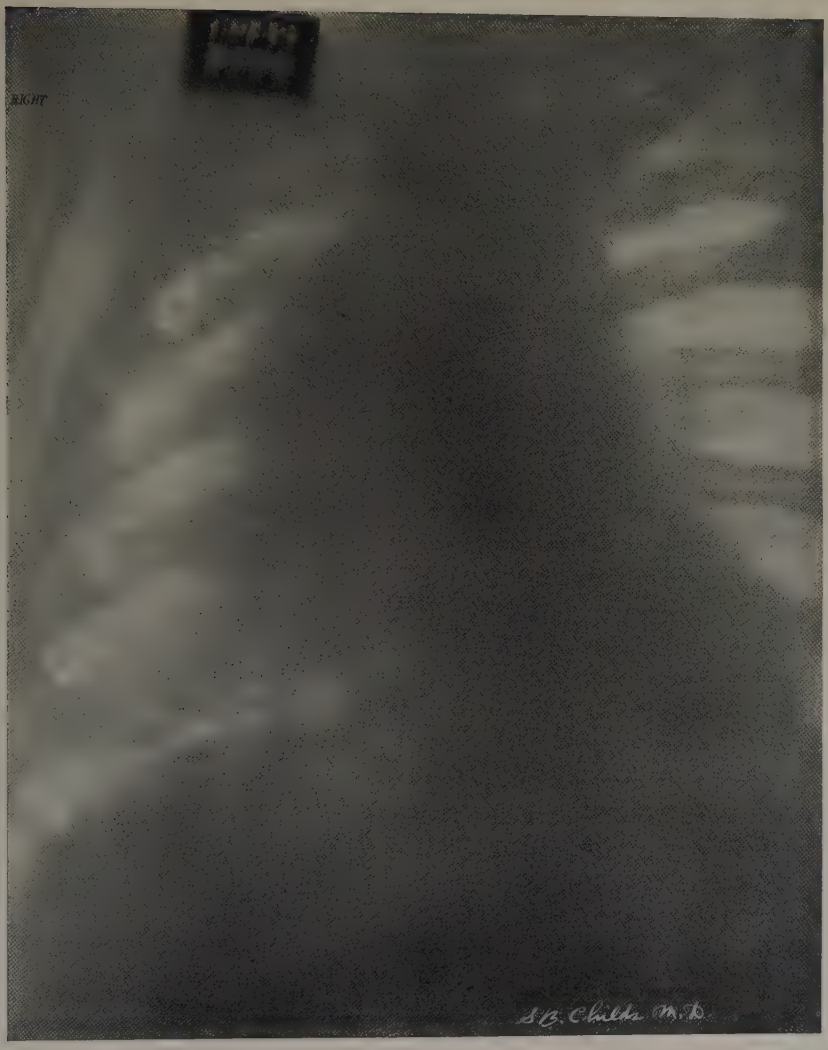


Fig. 90.—Anterior view. Large abscess in right lung, following pneumonia. Circumscribed shadow very closely simulating aneurysm, and blending with the shadow of the heart. Condition confirmed by autopsy (courtesy of Dr. Sewall).

CHAPTER XLI

DIFFERENTIAL DIAGNOSIS

The clinical manifestations of a few chronic non-tuberculous pulmonary conditions closely simulate those of consumption. While a provisional diagnosis may be made from the history, occupation, clinical course, and physical signs, in many instances, a definite differentiation from pulmonary tuberculosis is rendered possible only by exhaustive sputum examinations, and, in a few cases, through recourse to the newer methods of diagnosis. Occasionally even the presence of bacilli does not afford accurate information as to the precise nature of the pathologic change. This is particularly true of the so-called "miner's phthisis," difficult of disassociation from consumption, yet differing widely in the character of the morbid conditions. The appearance of bacilli only after long-continued observation does not justify the assumption of tuberculosis as a factor of etiologic importance. The terminal infection is merely ingrafted upon a soil previously made receptive by virtue of marked pathologic change. Miner's phthisis consists of an interactive combination of chronic bronchitis, emphysema, and pneumonokoniosis in connection with frequent bronchiectases and circulatory disturbances. The symptoms and general course are described elsewhere. In this connection it is sufficient to state that the clinical manifestations are very suggestive of tuberculosis, especially the cough, expectoration, dyspnea, and the occasional hemorrhages. There is rarely, however, any elevation of temperature. The cyanosis is quite disproportionate to the physical evidences of pulmonary involvement. The dyspnea rapidly increases until it is noticeable even upon the slightest exertion. The cough is usually paroxysmal, and the sputum frothy and light. The physical signs which are described in connection with pneumonokoniosis do not differ materially from those displayed by many cases of pulmonary tuberculosis. While often there are bilateral evidences of catarrhal involvement and emphysema, physical examination sometimes discloses signs of unilateral consolidation, with circumscribed areas of moisture and not infrequently pulmonary cavities. The history, occupation, absence of fever, disproportionate dyspnea, and cyanosis, the paroxysmal character of the cough, the frequent separation of the sputum into distinct layers, together with the bilateral signs of catarrhal disturbance and the coëxisting emphysema, with continued negative bacteriologic findings, suggest the essential non-tuberculous character of the condition, despite the occurrence of hemorrhage and the occasional unilateral involvement. There can be but little excuse for confounding pulmonary tuberculosis with acute or chronic bronchitis, bronchiectasis, uncomplicated emphysema, or chronic interstitial pneumonia. The fact, however, that this group of conditions in connection with varying degrees of pneumonokoniosis as frequently observed in mining regions, with or without cavity formation, constitutes a very considerable proportion of all cases of chronic non-tuberculous pulmonary affections, affords ample opportunity for errors in diagnosis. This grouping of conditions is more or less frequent in parts of Colorado, and is often confused with tuberculosis.

Other non-tuberculous ailments are found to present an apparent similarity to consumption.

The existence of chronic influenza is a frequent cause of mistaken diagnosis. I have seen this condition produce all the rational symptoms and physical signs of tuberculosis. These cases usually present the history of an acute onset, with moderate constitutional derangement and bronchitic disturbance. The cough is often paroxysmal, and the expectoration purulent, without tubercle bacilli, or other microörganisms except the Pfeiffer bacillus. Apropos of the rather strong similarity of the influenza infection to consumption, I will cite the report of a few cases which have come under my observation.

Case 1.—A striking illustration of the possible influence of this infection was observed four years ago in a child of ten years who was placed in my care about one month after the initial onset of her illness. In addition to general symptoms, including cough, loss of weight, physical weakness, and afternoon temperature elevation, there existed pronounced consolidation of the left apex, with fine moist râles in the infected area. During the following six weeks the consolidation gradually extended downward to the fourth rib and lower angle of the scapula, with moist râles throughout this region. There also developed an aggravation of the general symptoms, with increasing loss of weight. The physical condition remained stationary for the ensuing two or three months, when gradual improvement began to take place. Before the end of a year there was complete disappearance of cough and expectoration, with increased weight and no remaining evidence of the slightest pulmonary involvement. The child has remained absolutely well ever since. An interesting feature of this case is the fact that the progress of the consolidation corresponded to the so-called "line of march" of downward extension in tuberculosis on which considerable stress has been laid by some observers.

Case 2.—Another instance of the possibility of error resulting from the presence of the influenza bacillus was exhibited by a woman who has remained under my observation ten years, displaying, upon arrival in Colorado, signs of very active and extensive tuberculous infection of each lung. There has taken place an astonishing improvement, including a gain of over forty pounds in weight and a degree of strength and endurance quite exceptional. For over four years no bacilli have been found in the sputum, in spite of frequent examinations, and no evidence of existing tuberculous activity in the lungs, though signs of consolidation still persist. Two years ago there developed a severe influenza infection, attended with distressing cough, copious purulent expectoration, moderate elevation of temperature, and impairment of general strength and nutrition. Repeated examinations showed continued absence of tubercle bacilli, yet the physical signs resulting from extensive *fibroid* change in the lungs in connection with a *recent* bronchial catarrh *suggested* clearly an active advancing tuberculous process.

Without the laboratory findings a precise conception of the diagnosis and general outlook in cases of influenza infection following arrested tuberculosis would be utterly impossible.

Apart from the influenza bacillus, other microörganisms have been found to exert an apparent influence in the production of symptoms and signs distinctly indicative of tuberculosis. I have observed several

notable instances of the relation of the pneumococcus of Friedländer to these disturbances, in the absence of tubercle bacilli.

Case 3.—In 1896 a man from Vermont, recovering from tuberculosis in Colorado, was suddenly summoned home by the telegraphic announcement that his three-year-old boy was dying of acute pneumonic tuberculosis. He returned to Colorado immediately, bearing in his arms the child, who had been almost comatose the entire distance. The temperature had remained in the neighborhood of 105° F. and the pulse and respirations were found markedly accelerated. There were moderate cyanosis, stupor, and a partially consolidated right lung. The chief point of interest attaches to the delayed resolution, which was not completed for several years. There persisted for *fully a year a daily afternoon rise of temperature, continued cough,* with signs of consolidation and moist râles, *without tubercle bacilli.* The child is now perfectly well, after the lapse of eleven years, physical examination of the chest being entirely negative. It is almost impossible to conceive of this pneumonia as having been tuberculous, not only because of the absence of the bacilli, but also in view of the complete recovery in a child so young. Any attempt to explain the absence of bacilli by an alleged miliary disturbance with pulmonary manifestations is almost entirely controverted by the fact that the child recovered. Though undoubtedly an instance of pneumococcic infection, the persistence of the symptoms and signs strongly suggested a tuberculous process.

Case 4.—A woman, thirty-six years old, consulted me upon August 30, 1907, four years after the development of pulmonary trouble. The onset is of peculiar interest. In the midst of a laryngoscopic application at the hands of a well-known laryngologist a large pledget of cotton was permitted to enter the trachea. This was immediately followed by severe paroxysms of cough, the patient almost expiring from asphyxiation. She was subsequently confined to the bed for three months, suffering greatly from almost incessant cough and paroxysms of choking. The cough has persisted to the present time, though expectoration is scanty. There has taken place considerable loss of weight and strength, with dyspnea upon slight exertion. While fever is not uniformly present, the temperature is frequently elevated for weeks at a time. Physical examination discloses evidences of moderate infiltration of the right lung, with moist râles from apex to base, front and back, and on the left side from the clavicle to the fourth rib. There is pronounced retraction of the right upper chest. Confirmation of the physical findings will be observed by reference to the skiagraph (Fig. 88). It is scarcely conceivable that the results of physical and *x*-ray examination could indicate more clearly a genuine tuberculous invasion, yet repeated examinations of the sputum fail to reveal tubercle bacilli. A factor of essential importance is the history of an acute onset of pulmonary symptoms from obvious cause in an individual previously enjoying good health.

Another condition which may be the occasion of mistaken diagnosis is pulmonary syphilis. It cannot be doubted that this disease *coëxists* with consumption oftener than is generally supposed. In some instances the clinical evidences are *confounded* with those of pulmonary phthisis. The subjective symptoms of the two are almost identical, the cough, expectoration, loss of weight and strength, and even the physical signs being very suggestive of ordinary consumption. An

important difference in the clinical manifestations is the infrequent elevation of temperature. This must not be regarded as an invariable distinguishing characteristic, as it is known that fever may occur in pulmonary syphilis, and that many cases of consumption are devoid of temperature elevation for prolonged intervals. Suspicion is aroused by the absence of tubercle bacilli in the expectoration. This suggests the propriety of a rigid investigation regarding the history, which should embrace the admission or denial of an initial lesion, the existence of sore throat, rash, and loss of hair. Supplementary to this, there should be instituted a search for the external evidences of the antecedent disease. It should be emphasized that the stoutest disavowal of a syphilitic infection, coupled with the absence of clinical manifestations of the disease, constitutes no conclusive evidence as to its previous non-existence. The *grouping* of the subjective and objective symptoms of consumption *without* the bacteriologic evidences is sufficient to awaken a suspicion of pulmonary syphilis and justify the immediate employment of the iodids. That the two infections coëxist with considerable frequency no observer of pulmonary tuberculosis will be disposed to deny. This subject will be discussed more fully under Complications.

The diagnostic significance of pulmonary hemorrhage is sometimes subject to erroneous interpretation. In view of the fact that many cases of pulmonary tuberculosis present a hemorrhagic onset in the absence of previous subjective symptoms or physical signs, it follows that the occurrence of hemorrhage, even in individuals in apparent health, should immediately awaken a strong suspicion of incipient tuberculous infection. If hemorrhage develops in association with loss of weight, elevation of temperature, and cough, even without physical signs, a warrantable basis is furnished for a provisional diagnosis. It is essential, however, in cases with negative physical evidences of tuberculosis, to eliminate all other conditions possibly responsible for hemoptysis. Several times I have observed hemorrhages among patients presenting every apparent subjective indication of pulmonary tuberculosis, in the absence of definite physical signs, the bleeding being dependent upon other causes. A citation of a few cases may illustrate the opportunity for mistakes in diagnosis through incorrect interpretations of the significance of recurring pulmonary hemorrhage.

The first case relates to a dilated and hypertrophied right ventricle. In October, 1905, a woman of twenty-two years came to Colorado presenting the history of a progressive loss of weight and strength, with cough and expectoration, during a period of one year. There had been a continuous elevation of temperature, with occasional chills and night-sweats. She had bled from the lungs repeatedly. Upon the basis of these hemorrhages, in connection with the loss of weight and subjective symptoms, a diagnosis of tuberculosis had been made, and change of climate recommended. Upon examination, dulness was found in the left front from the apex nearly to the base, with complete absence of breath- and voice-sounds. A supposed apex-beat was visible well within the mammary line, but slightly elevated. In the posterior axilla and in the back crackling râles, of a greater intensity than can be described or imagined, were heard, both on inspiration and expiration, and recognized easily with the stethoscope slightly removed from the skin. No dulness was found at the right of the sternum, and it was

almost impossible to outline the left boundary of heart dulness. The cardiac impulse, however, could be felt nearly to the anterior axillary line, and murmurs of mitral stenosis and regurgitation were audible. Sputum examination was negative. A diagnosis was made of occlusion of the left bronchus from a dilated heart. Hemorrhages continued with considerable frequency during the ensuing six weeks. There were also periodic attacks of alarming dyspnea and cyanosis. Although a degree of dilatation still existed at the time she was sent home, there were no symptoms of cardiac embarrassment. In front there was considerably less lung compression and all adventitious sounds had disappeared from the back.

The next case illustrates, in the absence of mitral disease, the possibility of error in ascribing pulmonary hemorrhages to a latent or concealed tuberculous process even when associated with loss of weight and strength.

Nearly twelve years ago a man in middle life was sent to Colorado for supposed tuberculosis. I found him in bed, bleeding from the lungs and coughing moderately. The hemorrhages had been frequent for several months, and there had been considerable loss of weight and strength. There was marked pallor, weak and rapid pulse, but no fever. The examination of the chest was entirely negative. A diagnosis of purpura hæmorrhagica was subsequently established.

The next case still further illustrates the difficulties encountered in arriving at correct conclusions concerning the significance of hemoptysis:

A woman of nervous temperament was sent to Colorado in 1899 on account of very severe recurring pulmonary hemorrhages. Her husband, who was a physician, had made a diagnosis of consumption. Both parents and three brothers and sisters had died of tuberculosis, she being the only survivor. There was moderate dry cough, some expectoration, with loss of weight and a very considerable anemia, but chest and sputum examinations were negative. Shortly after arrival she suffered a severe pulmonary hemorrhage, followed by a recurrence of like character in exactly four weeks. It then developed upon inquiry that all her previous hemorrhages had occurred at a time corresponding to the menstrual period. The diagnosis of vicarious menstruation was promptly made, and the nature of the condition fully explained. Treatment referable to the control of the neurotic condition and the anemia sufficed to bring about an ultimate recovery.

SECTION II

PROGNOSIS

CHAPTER XLII

GENERAL CONSIDERATIONS

To the medical profession as a whole the general prognosis of pulmonary tuberculosis has hitherto assumed a minor degree of importance in comparison with other phases of the tuberculosis problem. Active organized effort has been centered largely upon the adoption and execution of preventive measures, but during recent years there also has been evolved definite knowledge as to the curability of the disease, by virtue of patient and intelligent endeavor. To the pulmonary invalid prognosis has ever been the one feature of supreme interest. Immediately upon awakening to a realization of the condition, the paramount question relates to the chances, if any, there are for recovery. The prognosis of consumption is subject to considerable elasticity of interpretation. This is readily appreciated in noting the innumerable intermediary results between complete recovery and early death. By *cure* in its technical sense is meant the absolute elimination of all tubercle bacilli from the body. This happy result, however, though possible of attainment in exceptional cases, is seldom acquired. The term "recovery" is not intended to imply a complete restitution to the normal of the pulmonary tissues, and an eradication of the bacillary invaders, but rather an enduring *arrest* of the infectious process. The *practical application* of *prognosis* refers to whether or not the infected individual will be permitted to secure a *permanent restoration of former activity and usefulness*. The suspension of an immediately fatal issue, followed by an indefinite period of invalidism, should not be construed as worthy of inclusion under a classification of favorable results. The proper interpretation of a so-called favorable prognosis involves a disappearance of bacilli and of the physical signs denoting active involvement, an apparent return of previous strength and vigor, an endurance which must not be subjected to unreasonable tests, and a restoration of earning power. It is evident that the degree of arrest and the time necessary for its acquirement are subject to almost infinite variation in individual cases. The flexibility of its application is emphasized by the wide range of clinical results. It is allotted to some to enjoy a conspicuous rehabilitation of health, with entire disappearance of subjective and objective signs. Others are destined to secure a temporary respite from imminently impending danger, with subsequent partial arrest of the tuberculous process, an indefinite quiescence of the disease permitting a measure of usefulness, although often in a different sphere of activity. The consumptive should be made to understand that once the tuberculous infection has become active, no matter how satisfying the later improvement, the general mode of existence is necessarily changed in many of its essentials. In most cases of arrested tuberculosis a minimum of sacrifice and suffering is secured only through a continued conformity to certain principles of daily living.

The prognosis of consumption is not only susceptible of uncertain construction as to its *general* meaning, but is at best of doubtful definition in *individual* cases. The formation of a definite prognosis is often attended with the greatest difficulty, by virtue of the divergent significance attaching to special symptoms. Certain existing manifestations reflect an important bearing upon *immediate* prognosis, although the ultimate outcome may be modified greatly by the advent of unforeseen complications. Often the unexpected is found to happen. Many patients apparently doomed to death by virtue of every accepted prognostic consideration are seen to make strikingly picturesque recoveries, while others, almost free from the influence of the disease, quickly succumb to an intercurrent pulmonary hemorrhage, with supervening aspiration pneumonia. Apropos of the not infrequent abrupt development of unfortunate complications, I have in mind two young men who have died recently from pulmonary hemorrhage, although having exhibited, during a period of two years, most gratifying improvement with complete disappearance of subjective symptoms and marked subsidence of physical signs. These patients I had regarded as practically out of danger, yet previous prognostications concerning a favorable issue in each instance were suddenly nullified by unexpected pulmonary hemorrhage. A similar revolution in the clinical aspects is often occasioned by other causes impossible of reasonable anticipation, as a severe attack of grip, bronchopneumonia, tuberculous meningitis, typhoid fever, pneumothorax, or nephritis. A series of cases will be later reported illustrating the occasional possibility of recovery even among seemingly hopeless pulmonary invalids.

It follows that the prognosis in many cases, while justly hopeful and reassuring, must be somewhat guarded in character. Special caution should be exercised not to pronounce unfavorable sentence without due consideration of all possible phases. An accurate prognosis seldom can be made upon the basis of the physical condition alone. The character of the subjective symptoms is of the utmost importance in the determination of the final issue. It is frequently impossible, from pure generalizations, to arrive at correct conclusions, as prognosis is largely a question of individual detail. No single factor should be assumed to be of paramount importance.

Inasmuch as it is not the disease alone, but rather the individual, representing the necessity of clinical study, it follows that intelligent prognosis must be reached through the combined influence of considerations pertaining, first, to the individual, and, secondly, to the disease.

CHAPTER XLIII

FACTORS PERTAINING TO THE INDIVIDUAL

In this general class are included the influence of age, sex, race, family history, individual resistance, occupation, temperament, disposition, intelligence, character, financial condition, social environment, personal equation in medical supervision, change of surroundings, and climate.

AGE

Age constitutes an important consideration in the prognosis of consumption. It has been my experience that the prognosis is decidedly less favorable in infancy and youth than in adult life. No child under eight years has secured an arrest of pulmonary tuberculosis while under my supervision. Not infrequently, however, have I been permitted to note the attainment of very satisfactory results in patients from eight to fifteen years of age.

Two conspicuous cases are cited for the purpose of illustration. In June, 1905, I discharged as cured a boy of eleven years who had remained under my observation precisely two years. At the time of arrival in Colorado his illness had been of four months' duration, following an acute onset with rapid subsequent decline, which was marked by high temperature elevation and extreme debility. As the details of this case will be reported in another connection, it is sufficient at this time to call attention merely to a few essential features. There were extreme emaciation, pallor, and pronounced dyspnea, the child, as the result of physical exhaustion, being scarcely able to stand upon his feet. Examination of the chest disclosed the existence of extensive tuberculous invasion of the entire left lung. Throughout this area were detected physical evidences of moderate consolidation, with fine moist râles from apex to base. It goes without saying that an unfavorable prognosis was almost unqualifiedly rendered. By virtue of the climatic change and rigid supervision, a surprising improvement was noted. The entire arrest of the tuberculous process was attended by an extraordinary fibrous tissue proliferation. The child has remained at home during the past two years, without visible retrogression. Upon being permitted recently to examine the patient, I was gratified to note unmistakable evidences of enduring arrest. Some idea as to the extensive fibrosis with resulting unilateral deformity may be obtained by reference to Fig. 91.

In May, 1906, a boy of fourteen was placed under my care, six months after an abrupt development of pulmonary tuberculosis. The family history was excellent. The entire life of the child had been spent in New Mexico until the early fall of 1905, when the family removed to Los Angeles. A severe cold developed shortly afterward, with persisting cough, expectoration, temperature elevation, and loss of weight. Upon arrival in Colorado the patient was anemic and much debilitated. On examination of the chest, moist râles were recognized in the left front, from the apex to the third rib, and upon the right side, from the apex to the second interspace. The left back was clear, but upon the right side moisture was detected to the lower third of the interscapular space. Tubercle bacilli were exceedingly numerous. In view of the marked constitutional change and extent of tuberculous involvement the prognosis was at best extremely guarded. Under strict disciplinary control a gain of fifty-five pounds was achieved in six months. There is now no temperature elevation, cough, or expectoration. Examination of the chest discloses entire absence of moisture in both lungs. The excellence of nutrition is displayed in the accompanying photograph (Fig. 92).

Clinical observations of this character have forced the conviction that the prognosis of pulmonary tuberculosis is decidedly better between

the ages of eight and fifteen than prior to eight, or between fifteen and twenty. In early life the process is invariably more active than in subsequent years, the absorptive powers being much greater and toxemia, as a rule, more profound. It is also likely that the capacity for absorption of toxic products is greater from eight to fifteen than in the immediately ensuing years, but its influence is more than offset by the far greater *docility* of patients at such time of life than in the years approaching manhood. Children around twelve are less inclined to disobedience, and much more amenable to discipline than in the neighborhood of fifteen to twenty. At the latter period they are more apt to be willful and difficult of restraint, even if without tendency to viciousness. This is especially noticeable among young people who have been subjected to the pernicious influence of indiscriminate petting and parental indul-

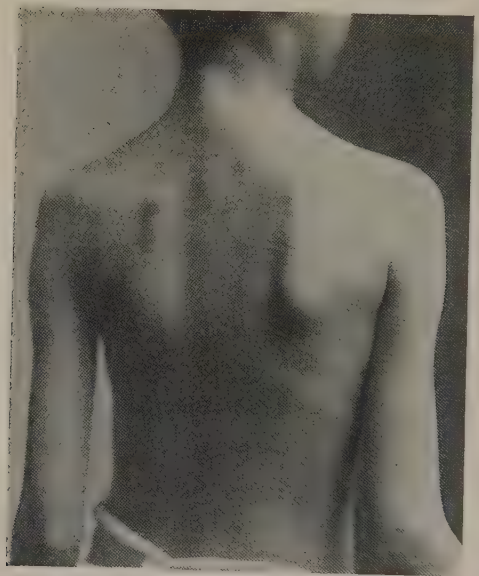


Fig. 91.—Marked unilateral deformity as a result of extensive fibrosis in a boy of eleven years.

Fig. 92.—Illustrating a gain of fifty-five pounds in weight in a boy fourteen years old with extensive bilateral involvement.

gence. The management of such patients is often fraught with exceeding difficulty. Although the natural disposition may be gentle and kindly, the temperament not essentially irritable, and the manner not domineering, the formation of character is necessarily incomplete, there often being exhibited an unfortunate lack of self-control or submission to the advice of others. Patients at this age have not reached years of discretion, and have not been permitted to acquire that maturity of judgment which is necessary to successful results. It has been my observation that the prognosis has improved with every semidecade from twenty to fifty, and diminished from that time onward. This has been more particularly true among males than females. In the latter, on account of the menopause, with its attending nervous disturbances, I have found the best results to obtain in the fifteen-year period from thirty to forty-five.

SEX

The influence of sex has been found to be of considerable prognostic importance, decidedly better results being observed among females than males. This is contrary to the prevalent impression regarding the bearing of sex upon prognosis, but the evidence, from my own experience, has been so overwhelming as to permit no other conclusion. In this connection it is interesting to note that the disease is generally considered to attain a greater prevalence among females, on account of their relatively diminished powers of resistance and their lessened opportunities for outdoor air, sunshine, and exercise. It has been assumed that these causes, sufficient to *invite* bacillary infection, may exert an unfavorable influence upon the *subsequent* course. It is noteworthy that, as a general rule, *opportunities* for promoting recovery through change of climate and environment are not offered to the female equally with the male. If energetic measures in the way of climatic change and rational management are instituted at all for the female, they are often deferred to later stages of the disease. In comparison with the promptness and celerity with which male members of the family hasten to avail themselves of all possible means of arrest, the tactics displayed for the relief of the females appear especially dilatory. It is somewhat surprising that the man of affairs, the tradesman, the professional man, and even the wage-earner seems better able to sever himself from his business responsibilities than the housewife from her domestic cares. From my observation it appears that no sacrifice is too great to deter the males, in general, from seeking early all possible aids toward recovery. The above considerations would suggest almost unavoidably a pronounced unfavorable prognosis attaching to tuberculosis in the female, yet despite adverse conditions and contrary to the opinions of others, it is shown that the ultimate outlook is actually better for females than for males. This conclusion has been reached not from statistical arguments, which are often fallacious, but purely from the logic of every-day experience. Upon reflection it is easy to understand why the members of the female sex should exhibit the better prognosis. Success or failure in the struggle to overcome the invasion by the tubercle bacillus depends largely upon the ability of the individual to conform to a strict régime, which demands for its most satisfactory accomplishment certain physical, mental, and nervous requirements. Assuredly these are possessed to a greater extent by the female. Although admittedly more susceptible to nervous influences, nevertheless, in the event of a tuberculous infection, she is better equipped by virtue of inherent and acquired tendencies to adapt herself to unusual conditions. She exhibits, to a marked extent, a diminished restlessness under imposed restraint, suffers a lesser strain incident to the cares and responsibilities of life, and bears a lighter burden of financial obligations. In addition, she manifests far less tendency to acts of imprudence and dissipation. She not only yields a more ready acceptance of the principles of early supervisory control, but her subsequent obedience and compliance with detailed instructions are more complete and implicit. Only in exceptional instances is separation from family, either in favorable climates or in sanatoria, harder for the female than for the male. In open health resorts the husband, if stricken with tuberculosis, is often accompanied by his wife, while the woman, if similarly afflicted, is usually alone. It

will be explained later that in the majority of instances the prospects of a successful issue are materially improved by the absence of the husband or other members of the family. It cannot be denied that the percentage of improvement among females is remarkably greater in those who are either unmarried or without family incumbrance.

An important factor in explanation of the better prognosis of females relates to the very fact of their *previous* indoor environment and the more complete subsequent transformation of the mode of life. Another element, applicable particularly to those who seek climatic change, consists of the relatively superior financial circumstances of the female invalid. Unfortunately, young men with extensive tuberculous involvement and sadly inadequate resources are often sent to health resorts with instructions to secure immediate employment. Many, financially impoverished, are compelled to work for a mere pittance in order to supply the imperative necessities of life. Further commentary is to the effect that while females are not privileged to take advantage of climatic change as frequently as males, as a rule, they are not hurried to health resorts without proper provision being made for their support.

RACE

Race has ever been found to exercise a considerable influence upon the determination of final results, as has been made clear in an earlier chapter. (See p. 59.) Its prognostic import may be regarded as a clinical truth incapable of controversial argument, although the actual scope of its effect and the precise manner in which it is exerted may be subject to considerable variation. Its prognostic bearing is due not infrequently to national differences of susceptibility to the disease. The utter lack of resistance against the ravages of tuberculosis is exemplified particularly by the prevalence and mortality of the disease among the American Indians. Its rapid dissemination among these people cannot be explained by the lack of outdoor air, sunshine, and exercise, or by the massing of large numbers of people in relatively confined sections. While sources of bacillary infection must exist to a degree in order to render possible the transmission of the disease, the essential consideration relates to the inherent vulnerability of the tissues.

Likewise among the negroes the morbidity of consumption is explained in part by an undue racial predisposition. That this does not constitute the *sole* consideration is shown by the great infrequency of the disease prior to enfranchisement of the race. The subsequent obligatory assumption of responsibilities to which they were ill adapted, together with squalid, unhygienic surroundings, have effected a diminution of vital resistance and afforded means of acquired infection. Complete and enduring arrest of pulmonary tuberculosis is extremely rare among the colored race, although I have seen a few notable instances of such an occurrence in Colorado. The course of the disease is usually rapid, attended with progressive excavation, and marked by a high degree of toxemia.

A striking illustration of the occasional complete arrest of the tuberculous process in the negro is found in the following case: The patient, aged forty-five, developed well-defined evidences of pulmonary tuberculosis two years ago. The physical examination disclosed a massive consolidation of the left lung, with characteristic constitutional

disturbances, the loss of weight and general prostration being pronounced. There has taken place an entire arrest of the tuberculous process, with complete absence of subjective symptoms. The extent of pathologic change is illustrated in the skiagraph recently taken (Fig. 57), and the present excellent nutrition in Fig. 93.

It should be added, however, that this rather unusual result is largely explained by the fact that exceptional opportunities were afforded for securing an arrest.

The prevalence of the disease and its high mortality rate among the Irish people can hardly be explained by their social conditions or methods of living. A decided lack of resistance is exhibited by the wealthy and highly educated, as well as by the poor and ignorant. It must be assumed that Celtic temperamental characteristics have an intrinsic bearing upon the prognosis. Though brave to a remarkable degree in the face of imminent danger, the Irish courage in the absence of a critical emergency is not attended with that unswerving tenacity of purpose so

Fig. 93.—Complete arrest of advanced tuberculous infection in negro.

necessary for the maintenance of a protracted régime. The prognosis among the Irish is less favorable than in any other Caucasian race. Their neighbors, the Scotch, although endowed with less mercurial tendencies, are often more difficult to manage on account of their proverbial stubborn characteristics, a continuous suitable régime being frequently out of the question.

The Swedes, from my personal observations, appear to be more susceptible to consumption than the Norwegians, Danes, or Dutch. In spite of their historic endurance and hardiness, they have exhibited an unexpected lack of resistance after the infection is established.

The English and Germans particularly excel in their unwavering adherence to a fixed systematic régime. I have found the prognosis among these people markedly favored by their dogged perseverance in endeavoring to secure arrest, unmindful of external distractions and allurements.

The Americans offer a less favorable prognosis than their more stoical kindred of English descent or their phlegmatic German cousins. The spirit of unrest and endeavor incident to the strenuousness of American life characterizes to a certain extent the pulmonary invalid of our own country. All too frequently it is asserted that recovery must take place within a certain stipulated time limit, which represents the maximum period allotted for the consummation of the desired result. The American charges into the proposed struggle for arrest with an impetuosity and enthusiasm corresponding to the energy displayed in commercial life or professional pursuits. Upon attaining a tangible improvement, he frequently cannot refrain from resuming his former duties, despite an incomplete arrest of the tuberculous process.

Of all people, the Hebrews present the most unique and picturesque exhibition of racial influence upon the prognosis of consumption. The historic condemnation of the Jews to the ravages of disease seems literally to have been fulfilled in the prevalence of tuberculosis among these sorely afflicted people. In direct accordance, however, with their wonderful survival of persecution is observed, in many instances, a remarkable immunity to the toxins of pulmonary phthisis. Though quite susceptible to infection and unable frequently to overcome the tuberculous process, they, nevertheless, exhibit powers of resistance which are indeed marvelous, despite the existence of extensive areas of destructive change. Early in my experience with pulmonary invalids there was noted in Hebrew patients a disproportion between the physical signs and the general condition. While, as a rule, the course of the disease is prolonged indefinitely, the process of arrest is slow and disappointing. The Jew is usually obedient and conscientious to the last degree in following instructions.

FAMILY HISTORY AND PREVIOUS HISTORY

The etiologic relation of an inherited predisposition has been discussed in a previous chapter. After the disease is *acquired*, the family history must be accepted as having some bearing upon the ultimate outcome, although its prognostic import is not a factor of especial importance. The absence of a tuberculous family history has but slight, if any, favorable significance, but a strong hereditary taint renders the outlook for eventual arrest somewhat more gloomy in the majority of cases. A negative history of tuberculosis among immediate ancestors, if accompanied by a record of several deaths among the brothers and sisters, must be construed to indicate an impaired resistance characterizing the present generation. Deaths among brothers and sisters are frequently observed to take place at about the same age, suggesting that the powers of resistance, sufficient to withstand infection up to a certain point, are finally exhausted. Such a family record is undoubtedly a factor worthy of some consideration in a determination of the individual prognosis.

The prognosis is influenced to a marked degree by the apparent resistance of the *individual*, as exhibited in a review of the previous career. This should embrace the history of infancy and early life, the record of previous diseases, their duration, severity, sequelæ, and an inquiry of past and present habits. Children whose parents (either one or both) at the time of conception were exhausted by disease or dissipa-

tion, are likely to be puny and delicate in infancy and to present the history of many severe illnesses during later childhood, with distinct manifestations of impaired strength and vitality in adult life. This element of diminished resistance to disease is shown in prolonged and tedious convalescence from typhoid fever or other constitutional affections. If to such a history as this are added the unfortunate effects of dissipation or excesses of any nature, there results an inevitable shadow upon the final prognosis.

OCCUPATION

Considerable importance has always been attached to the influence of certain occupations upon prognosis. The inhalation of palpable dust by stone-cutters, glass-workers, potters, millers, grinders, and either coal or metalliferous miners has been regarded as particularly unfavorable. Conclusions entertained with reference to the unfortunate outlook for such persons are unquestionably correct, although the tuberculous element in these cases is entirely secondary to the antecedent pathologic change. While consumption is not the essential cause of death, the fact remains that the ingrafting of a terminal bacillary infection upon a combination of morbid conditions, as chronic bronchitis, emphysema, pneumonokoniosis, and circulatory disturbance, carries with it a profound impression as to a fatal issue.

Generally speaking, the prognosis is bad among people whose occupation involves confinement during many hours of the day, in small, ill-ventilated, and overheated rooms, as in factories and workshops. It is universally conceded that people engaged in indoor pursuits with marked sedentary habits are more likely to become subjects of tuberculous infection than their more fortunate fellows who enjoy an outdoor existence. It does not follow, however, that the former class possesses inferior opportunities for *subsequent recovery*. The primary *causal* factor among such individuals relates to a diminished resistance resulting from impaired general health. This may react to their ultimate disadvantage chiefly from a *continuance* of the same unfavorable environment. It has been my observation that invalids previously subject to more or less confinement are afforded a much better outlook after they conform to a system of rational management than those who have pursued an active outdoor occupation. An explanation of the more favorable prognosis in the former group is found in the more radical change in mode of life and consequently a greater impression upon the general health.

Farmers and athletes who not only are accustomed to living out-of-doors, but also are trained to superior muscular development, are less likely to get well after consumption has been contracted than those occupying clerical positions. Thus the bookkeeper, who sits for hours at his desk in a cramped anterior posture, though much more likely to develop tuberculosis than the team-driver, offers a much better prognosis. The change to an outdoor life is usually followed by immediate general improvement, which is denied to those already habituated to an open-air existence. Among no class of people is the disease attended with less favorable results than in those accustomed to feats of physical strength involving prolonged effort and unusual endurance. In the same way it has been my observation that the more favorable the

climate in which the infection occurs, the less hopeful the prognosis. In Colorado, while indigenous consumption is relatively infrequent, when once acquired, the subsequent course is usually rapid.

TEMPERAMENT, DISPOSITION, INTELLIGENCE, AND CHARACTER

There are but few favorable factors influencing prognosis of greater import than a phlegmatic attitude, gentleness of disposition, alertness of intellect, and strength of will. Individuals endowed with a philosophic temperament are less subject to nervous irritation, resulting from the annoyances and worriments incident to their environment and the indefinite period of invalidism. The benefit accruing from such a temperament is greatly accentuated by a cheerful disposition, keen intelligence, and strength of character. The stoical attitude, if not thus reinforced, may be less advantageous even than a distinctly nervous temperament, *supplemented* by mildness of disposition, firmness of will, and refinement of manner. I have found improvement in patients exhibiting decided nervous tendencies without pronounced neuroses, quite as frequently as among those devoid of all excitable proclivities. This is due to the fact that such persons are more keenly alive to the importance of their condition, more amenable to advice, and more conscientious in observing specific instructions. While in general the phlegmatic temperament is assuredly more conducive to good results than the irritable or unstable, an attitude moderately nervous often affords more active coöperation and obedience on the part of the patient. Rather high degrees of irritability present serious obstacles to a successful issue, but simple restlessness and excitation of manner, under rigid and tactful management, may yield fairly satisfactory results. As the neurotic disturbance increases the balance at once is thrown to the disadvantage of the individual. While the exhibition of nervous tendencies always imposes more exacting demands upon the energy, patience, and skill of the medical adviser, a resourceful and tactful response is frequently sufficient to minimize their unfavorable influence.

Innate cheerfulness of disposition modifies prognosis to an enormous extent, as the time element in the arrest of the disease makes unceasing call upon the patience and hopefulness of the invalid. The optimism of the cheerful and sanguine, supported by an *active* coöperation, is far more desirable than the pessimism of the depressed and melancholic, even if accompanied by passive obedience to instructions. A happy, contented disposition enables the invalid to make the most of all successes and to minimize the import of temporary discouragements. Patients displaying a despondent or surly nature, on the other hand, are unwilling to accept the true significance of any favorable aspect, and are apt at all times to misconstrue motives, exaggerate trifles, and take offense at imaginary slights.

Discriminating intelligence is of the utmost value, as it insures in the mind of the individual a precise conception of the nature of the disease and the manner in which an arrest may be secured. It often affords a comprehensive understanding of the rationale of therapeutic methods, and thus permits a far more ready acceptance of the enforced régime. To such patients there is usually but little occasion for argument, as a simple statement of directions is sufficient to entail implicit obedience and to establish relations of mutual sympathetic coöperation.

The character of the patient is of vast importance in the continuous maintenance of an enforced régime. An unyielding determination to succeed is of no less value in the effort to recover from consumption than in other departments of human endeavor. Strength of will enables the invalid to rise above temporary obstacles and discouragements to which the weak and vacillating often succumb. Patients exhibiting indomitable perseverance and tenacity of purpose may be depended upon to pursue steadfastly the course which has been outlined, regardless of distracting influences.

FINANCIAL CONDITION

The financial status must be regarded as a factor of considerable importance in the ultimate prognosis. There is a measure of truth in the saying "Only the rich can afford to have consumption." Such aphorisms, however trite, fail to convey accurately and completely the logic of actual facts. Although embarrassed resources certainly represent in many cases a serious obstacle to the attainment of best results, a large number of pulmonary invalids, despite this handicap, are enabled to achieve final success. It is not so much the *size* of one's bank account which permits a comparatively easy path toward arrest, but rather the judicious adaptation of the method and environment to the available funds. It has been my experience that impecunious circumstances, unless extended to the point of abject penury, furnish no insurmountable difficulties in the way of recovery. There is likely to exist among the poor a keener appreciation of the exigency confronting them, and hence a lesser likelihood of retrogression through dissipation, frivolous excesses, or other acts of indiscretion. The desire to take advantage of every reasonable facility at their command is especially overpowering to patients with small means or those dependent upon the assistance of others. By virtue of their financial limitations there is usually observed a conscientious adherence to the principles of systematic living. The financial condition is, at the very most, but a single factor among many, each of which has its due weight in a determination of the final issue. Even a greatly restricted income, if associated with *other* conditions of favorable moment, is more to be desired than affluence if unattended by similar propitious factors. The prolonged period of invalidism, the demand for superalimentation, and the requirement of a proper social and hygienic environment illustrate the value of an ample fortune, but not its invariable necessity. In view of the sanatorium provision in many parts of the country, a meager monthly allowance is often sufficient to supply actual needs. For people with inadequate resources, however, a practical difficulty is experienced at the time of *departure* from sanatoria. The end of their stipulated period of régime is followed in many instances by a return to work and to an eminently unsuitable environment. A rational solution of the problem for such invalids consists of the excellent opportunities at their disposal in favorable climates. A class of patients with limited means, though not absolutely impecunious, are offered assuring possibilities of improvement from climatic change, provided accurate information is obtained in advance concerning appropriate accommodations at a minimum expense. Patients dependent largely upon their own efforts for support, but exhibiting only incipient infection, are often

permitted to secure arrest through outdoor employment in favorable regions. Many who are less fortunate than their fellows in their financial equipment, possess other compensatory factors of favorable prognostic import, and with slight assistance in the beginning, are restored to their former usefulness and activity. This course of remark is presented to emphasize the fact that a moderately restricted income is not in itself an insurmountable obstacle to success.

SOCIAL ENVIRONMENT

Few factors pertaining to the future welfare of the patient are of more importance than a hopeful and cheerful social atmosphere. In some cases the presence of the husband or wife may be of inestimable benefit in promoting the comfort and contentment of the invalid, and in guarding against indiscretions. In other cases, no matter how well conceived the intention or devoted the service, incalculable injury is inflicted through absence of tact, perversions of judgment, and obliquities of disposition. Little children may be regarded in all instances as decided incumbrances to the progress of the patient, although mothers are prone to insist upon their decided influence for good, and protest strenuously against even a temporary separation. There is imposed a demand for careful individualization under such circumstances, precipitate action not always improving the immediate prospects of the invalid. In general, children, regardless of their intelligence or gentleness of disposition, are of necessity a source of added care and anxious responsibility and cannot fail to disturb to a marked extent the quiet régime of invalidism. Segregation of the patient insures, in the majority of cases, more satisfactory results than are otherwise attained. The ready adaptation of the consumptive to a proper social environment affords in part a favorable estimate as to the possibility of final arrest. It should be remembered that it is not the patient alone whose temperamental peculiarities demand thoughtful consideration, but, unfortunately, the accompanying relatives as well. Many invalids are compelled to pay the penalty for the perversity, ignorance, and delusions of members of their family. In such cases the prognosis varies according to the keen discernment of the physician and his insistence upon removal of unfavorable social influences through such isolation as may be reasonable and practicable. While patients are not always ready to accept at once the wisdom of such advice, if presented firmly and tactfully, the difficulties of its execution often are removed.

PERSONAL EQUATION IN MEDICAL SUPERVISION

From the foregoing considerations it is easy to comprehend that the welfare of the patient is influenced to a remarkable extent by an interested, painstaking regard for detail on the part of the medical adviser. The best results can be obtained only through a certain inherent aptitude of the physician, a devotion to the work in which he is engaged, and a personal solicitous interest in the individual. To discharge properly the many obligations incident to the care of the consumptive, and to assume with composure and confidence the anxious, vexatious responsibilities imposed, the physician must possess to an unusual degree patience, determination, vigilance, sympathy, tact, and enthusiasm.

The extent to which such endowment is possessed determines largely the welfare of the patient and frequently is sufficient to change impending failure into ultimate success.

CHANGE OF SURROUNDINGS AND CLIMATE

As a general rule, the chances for recovery are greatly enhanced if opportunity is afforded for suitable change of environment. Patients are much less likely to do well at home, as the difficulties in maintaining a proper régime are sufficiently great to interfere with the accomplishment of the best results, and to suggest the impracticability of the attempt, when possible to avoid it. Not only are the social conditions non-conducive to an unbroken period of nervous and physical relaxation, but the incidental interruptions, by friends and relatives, unavoidably impair the good effects of a systematic régime. The situation of the dwelling with relation to other buildings often is not such as to afford a sufficient amount of fresh air and sunshine. Atmospheric contaminations may exist by reason of smoke, dust, and other impurities. Assuming an advantageous location of the residence, there may be lacking ample porch accommodations, preventing the possibility of attaining rest and fresh air jointly. The perfect fulfilment of these cardinal features of management is likely to be achieved only when special provision is made for the reception of pulmonary invalids.

Due cognizance should be taken of the value of the psychic element attending a change of environment. The novelty of radically differing surroundings is a factor of the utmost importance in inspiring the patient with a degree of hope far in excess of that evinced at home. The invalid is forcibly impressed with the fact that something definite and tangible is being done to promote recovery, and often an abiding confidence is thereby established. This is especially likely to be the case if brought in contact with others who, through the force of example, instil an ambition to pursue an appropriate routine and, through the recital of their favorable progress, infuse transcendent faith in the attainment of similar results. A consideration of no slight importance relates to the direct educational influence exerted upon the patient in properly managed local institutions. Residence in sanatoria, even without the involvement of climatic change, is a factor of unquestionable prognostic value.

Change of climate in properly selected cases, with or without recourse to sanatorium control, is of far-reaching importance in the effort to secure an enduring arrest. While improvement in many incipient cases assuredly may take place by virtue of intelligent systematic management in relatively unfavorable climates, the chances for such happy results are not equal to those presented in more healthful resorts under the same conditions of management. There can be no question upon the basis of actual experience that the prognosis is wonderfully improved by removal to a suitable climate. Not only are the opportunities for arrest of the tuberculous process immeasurably greater, but stranger assurances are afforded for its enduring *maintenance* upon the active resumption of a useful occupation.

CHAPTER XLIV

CONSIDERATIONS PERTAINING TO THE DISEASE

Much importance attaches to the history of the present illness, the physical signs, the evidences of apparent immunity, the extent of systemic disturbance, and the development of complications.

HISTORY OF PRESENT ILLNESS

Rigid inquiry concerning the early history of the disease will often disclose data of vital prognostic interest. The method of onset may be suggestive of the subsequent type and termination. Many cases with an abrupt invasion after the manner of acute pneumonic phthisis or acute miliary tuberculosis may be expected to pursue an exceedingly rapid course, with a correspondingly unfavorable prognosis. When the onset is characterized by other acute manifestations, at least an intimation may be afforded concerning the clinical course; thus acute septic disturbances, if predominating early in the disease, often persist to the very end. While initial hemorrhages usually call emphatic attention to the pulmonary condition and induce a more ready adaptation of the invalid to a suitable environment, it cannot be assumed that the existence of early pulmonary hemorrhage exerts any inherent influence upon prognosis. Pulmonary tuberculosis supervening immediately upon an attack of influenza is usually of serious prognostic import. The individual resistance at such a time is comparatively slight, and the disease, in the larger number of cases, advances rapidly to destructive tissue change and pronounced constitutional impairment. Within certain limits it is safe to assert that the more acute the onset, the less favorable the prognosis and the more insidious the invasion, the greater likelihood of effecting an arrest.

Exclusive of the manner of onset, a review of the extent and nature of systemic disturbance is also of considerable value in establishing a reasonable prognosis. The history of progressive loss of weight and strength, with fever, chills, night-sweats, and increasing dyspnea, suggests, of course, a far less favorable prognosis than obtains in afebrile cases without constitutional impairment.

The previous duration of the disease is not without some significance, although it is scarcely true that the longer the condition has persisted, the less favorable the prognosis. If the infection has been of long duration and unattended by progressive pulmonary invasion or by symptoms of severe constitutional derangement, it may be assumed that the invalid possesses unusual powers of resistance, and that these fighting qualities, under proper management, may be later directed to a successful issue. After a period of disastrous delay, however, there inevitably must come a time, *soon* for some, *later* for others, and *finally* for *all*, when the patient becomes utterly unable, even with strenuous efforts of management, to display anything like former combativeness against the disease. It thus follows that while a prolonged duration, in the absence of distinctly unfavorable manifestations, may be construed as a favorable prognostic consideration in some cases, yet delay in the adoption of rational management results in a decided loss of opportunity in the effort to secure arrest.

PHYSICAL SIGNS

The physical signs are of signal importance as indicating the area of tuberculous infection, the nature and activity of the process, the extent of destructive change, and the amount of tissue fibrosis. The morbid pulmonary changes thus disclosed, although of essential value in an approximate estimate of the final results, are sometimes of far less prognostic importance than the accompanying symptoms. In view of the striking lack of conformity between the physical signs and the subjective symptoms, it is apparent that the former alone are quite inadequate for the purposes of prognosis. Many patients exhibiting extensive active areas of involvement display wonderful powers of resistance and secure an ultimate arrest of the infection. Others with comparatively slight evidence of pathologic change in the lung nevertheless decline rapidly to a fatal issue, despite the best conditions of management and environment. The physical signs are of especial prognostic value in *connection* with the associated evidences of constitutional disturbance, when their significance becomes of vital importance.

The *area* of involvement, regardless of other considerations, is not always of vital prognostic import, the size of the infected region being of much less moment than the character of the tuberculous process and its degree of activity. A diffused infiltrative tubercle deposit without definite consolidation, abundant moisture, or softening offers a far more hopeful outlook than a circumscribed area of infection associated with advancing destructive change. The extent of bacillary distribution in pulmonary tuberculosis becomes of especial prognostic interest in proportion to the degree of secondary inflammatory disturbance and accompanying degenerative change. Other features of prognosis being equal, it is, of course, true that the outlook is better among patients exhibiting comparatively small areas of infection. A limitation of the disease at one apex is of more favorable import than a bilateral involvement. It is insisted, however, that efforts to forecast the future of the invalid strictly according to the boundaries of tuberculous infection are without warrantable basis. Attempts of this kind represent a profound misconception of the nature of the various pathologic processes, the influence of constitutional symptoms, and other prognostic data.

Chief importance attaches to the character of the lesions, the activity of the infection, and the tendency to cavity formation. Infiltrative processes are more susceptible to complete arrest through fibrous tissue proliferation than are areas of massive consolidation, in which subsequent softening with excavation is likely to take place. In the latter event the constitutional symptoms are often more severe, the tuberculous extension rapid, and the course of the disease comparatively short. In some cases, however, consolidation, even of an entire lobe, may continue indefinitely without resulting cavity formation or persisting systemic disturbance. A conspicuous example of this phenomenon is shown by the following case:

In June, 1897, a gentleman of forty-eight, a patient of Dr. Babcock, came to Colorado, exhibiting a massive consolidation of the entire left lung with abundant moisture throughout. There were marked emaciation, physical exhaustion, fever, and rapid pulse. He returned to

Indiana in May, 1903, thirty pounds heavier, without fever or other evidence of constitutional disturbance, exhibiting not the slightest physical evidence of remaining tuberculous activity, although the consolidation was complete and the function of the lung entirely suspended. He has continued without retrogression to the present time.

While successful results of this character are sometimes observed, the prognosis, as a rule, is unfavorable in cases of gross pulmonary consolidation.

Scattered areas of pneumonic consolidation supervening in the course of pulmonary tuberculosis are occasionally followed by apparent resolution, but softening and cavity formation are the usual sequelæ. If arrest of the tuberculous process eventually takes place, there is necessarily an enduring loss of functional activity throughout the diseased area. In some instances the prognosis, as a result of the functional impairment and the physical incapacity of the invalid, relates chiefly to a prolonged period of restricted activity. Corresponding to the degree of respiratory limitation, the patient may either be permitted to enjoy a useful career, or be doomed to a life of complete invalidism.

The *activity* of the infection *is disclosed to a great extent* by the *amount of moisture within the bronchial tract.* Despite pronounced indications of general improvement, rather definite information concerning a remaining active tuberculous process is afforded by the recognition of fine and medium-sized moist râles. No tuberculous deposit can be regarded as arrested or even quiescent so long as these physical evidences persist.

There is no invariable relation between the state of the tuberculous lesions and the amount of cough or expectoration. I almost daily observe patients exhibiting moist râles upon examination, yet having but slight cough without expectoration. In the presence of bubbling râles the tendency to further extension of the tuberculous process is greatly enhanced, irrespective of subjective symptoms. Waiving temporarily a consideration of other elements influencing prognosis, it is fair to assert that the chances for recovery *are improved in proportion to the diminution of moisture in the infected area.* Prior to its complete disappearance favorable prognostic indications consist of a reduction in the size of the râles, a lessening of their distinctly bubbling character, and their non-recognition save upon the act of coughing.

The extent of tissue destruction as represented by pulmonary excavation adds greatly to the danger of hemorrhage and the likelihood of septic absorption. This, with the accompanying evidence of advancing infection, constitutes an important factor in prognosis. In some cases the cavity *per se,* even if it be of considerable size, may possess but little significance regarding the probable outcome. If surrounded by indurated lung tissue, it may gradually diminish in diameter through interstitial contraction to such an extent as to prevent its further recognition. The unfavorable import to be attached to cavity formation relates to the rapidity of development, the progressive increase in size, the accompanying moisture, and the subjective symptoms. Aside from gurgling râles over the site of the excavation, an indication of the activity of the infection is found in the amount of moisture present within an adjacent zone. Coarse bubbling râles in close proximity to the cavity suggest a further extension of the destructive process. Even rapid cavity formation may not always be construed as of unfavorable import,

though this assuredly is the general rule. The first clinical manifestations of general improvement are occasionally observed only after a rapid excavation with elimination of innumerable virulent bacilli and diminution of toxic absorption. As a general rule, the prognosis improves in proportion to the proliferation of fibrous tissue. In exceptional instances the fibrosis assumes such undue prominence as to occasion circulatory embarrassment through obliteration of the finer subdivisions of the pulmonary artery. With extensive fibrous tissue change there may result such disturbance of physiologic function as to incapacitate the individual for an existence beyond the limits of passive invalidism.

EVIDENCE OF APPARENT IMMUNITY

The relative immunity of individuals to tuberculous invasion is of much interest from a prognostic standpoint. Two essential influences are worthy of consideration, *i. e.*, differences in the virulence of the bacillus and in the resistance of the host.

The former has been demonstrated by experiments upon animals and by the results of laboratory investigation. Cultures of tubercle bacilli inoculated into guinea-pigs have produced death of the animals in three or four weeks, while inoculations of similar animals with bacilli from another source of infection have been followed by death only after considerably longer intervals, denoting a decided difference in the virulence of the cultures. Thus it may be assumed that in the human being a corresponding variation of virulence may exist, and represent a factor of some importance in the evolution of individual immunity. Some enthusiastic observers have even attempted to forecast a prognosis from the character of the clinical manifestations exhibited by the person from whom a recent infection is ostensibly derived. Thus a benign type of the disease is alleged to attend an infection acquired from contact with invalids exhibiting quiescent tuberculous processes. This line of thought presupposes a predominant influence of the bacillus as a factor in prognosis, to the exclusion of all considerations pertaining to the resistance of the host. Such conclusions are utterly at variance with the results of clinical observation. In numerous instances I have noted a rapid course and a fatal termination of pulmonary phthisis in the husband or wife, while the infection of the consort from whom the disease was contracted remained inactive for years or became entirely arrested.

Aside from inherent differences as to the virulence of the bacilli, a pronounced influence upon their virulent action is exerted by the character of the soil.

The individual resistance may be active and aggressive, or the defense of the organism may be comparatively slight. In some people the power to withstand the bacterial infection applies to the destructive change, and in others to the accompanying toxemia. It is well known that marked differences are exhibited by invalids in their susceptibility to the tuberculous invasion, and that the prognosis improves in proportion to the apparent resistance. To what extent in the determination of the resulting immunity the influence of the host is exerted upon the bacillus and vice versâ is difficult of differentiation.

The trend of modern thought does not incline to the recognition of the bacillus as the factor of greater importance. Clinical evidence

as to the determining influence of the soil is demonstrated in the transformation of virulent bacilli into microörganisms of the attenuated type, as a result of progressive general improvement. It is not uncommon in the observation of a single case of pulmonary tuberculosis that short, thin, bright-staining bacilli devoid of granulations, and characterized by an even stain, are subsequently found to become long, thin, beaded, and to stain unevenly. The fact that the attenuated variety make their appearance only in proportion to the evidences of physical and general improvement may be construed as of material significance.

CHARACTER OF SYSTEMIC DISTURBANCE

Among the subjective symptoms endowed with variable degrees of prognostic significance, fever is by all odds the most important. There is no single feature throughout the entire clinical course of the disease of more fateful import than a persisting high temperature elevation. As previously explained, the true influence of fever in a determination of the final result depends upon its height, cause, and duration, but its unfavorable effect is exerted chiefly by virtue of its persistency. While fever may greatly modify the clinical course, its existence is not always precursory of disaster. A stubborn temperature elevation is often susceptible of great amelioration, if not of complete control, according to the nature of therapeutic management. Therefore, high fever must not be accepted as an element of fatal import until its unyielding nature has been demonstrated by exhaustive clinical effort.

An undue acceleration of the pulse independent of fever or other obvious cause must always be regarded as of unfavorable moment. At the time of examination it is often impossible to judge accurately concerning the character and rate of the pulse by reason of coëxisting nervous excitement. An inordinately rapid pulse, occasioned by exercise, mental emotion, or excitement, is rarely an insuperable obstacle to arrest, but continuous acceleration, constituting a true tachycardia, is possessed of grave significance as regards the remote prognosis. While less optimistic opinions must be rendered with reference to this condition, a conscientious application of hygienic principles of management may result in ultimate recovery.

The degree of nutrition has been described as a consideration of momentous importance. A progressive diminution of body weight, despite the existence of other features of favorable significance, must be construed as a factor of ill omen. However, in some instances of extensive fibroid change involving both lungs, with marked impairment of function, a considerable loss of weight may accompany even an entire arrest of the tuberculous infection. These cases are seldom observed, but are conspicuous on account of the disparity between the external appearance and the physical signs. The fullest significance of emaciation is reflected in failure to respond to superalimentation and rest. Much more frequently, however, is loss of weight dependent upon diminution of appetite and disturbances of digestion.

Comparatively slight importance is attached to the acute gastric and intestinal symptoms resulting from an injudicious interpretation of the principles of superalimentation. Digestive disturbances occasioned by continuous dietary indulgence must undoubtedly influence prognosis, but the intelligence of the patient and physician usually is sufficient to

guard against too frequent repetition of such disorders. As a feature of prognosis, the practical disadvantage of digestive derangement consists of the confirmed loss of appetite and the inability, without this, to conform to a satisfactory system of dietetics. A poor stomach represents one of the most serious obstacles to a successful issue.

The prognosis is also influenced materially by the physical findings in the upper air-passages, heart, liver, and kidneys. As stated elsewhere, a passive congestion of the liver is possessed of decidedly unfavorable import. Grave significance must necessarily be attached to many forms of kidney disturbance which have been described. Decided arteriosclerosis invariably has an unfortunate bearing upon prognosis. The influence of enteroptosis and the various psychoneuroses, together with the prognosis of laryngeal tuberculosis, pleurisy with effusion, empyema, pneumothorax, and other complications, will be discussed in their appropriate place.

The cough is of but slight interest as a feature of prognosis. Extensive bronchial irritation may exist even in the presence of satisfying gain in the pulmonary condition, but subsidence of cough and expectoration at such a time adds hopeful color to the permanency of the improvement. The cough may be distinctly disadvantageous on account of the resulting exhaustion, disturbance of sleep, and the production of reflex vomiting. Generally speaking, however, it is idle to suggest a relation between the degree of cough and the probable outcome.

The number of bacilli demonstrable in the expectoration is not always endowed with especial prognostic import. A reasonable construction to be placed upon their relative frequency is to the effect that their gradual diminution constitutes a favorable indication, particularly in connection with their increasing attenuation.

In view of the encouraging outlook for the pulmonary invalid of to-day, as compared with the pessimistic attitude of the profession in the past, it will be of interest to read the following from an address delivered by Dr. Oliver Wendell Holmes in 1867 before the Harvard Medical School. These words by one universally revered by the medical profession are introduced largely because of the singular beauty of expression. In his simple and inimitable style he depicts the old-fashioned manner of medical instruction by presenting to one's imagination a worthy physician making his round of visits accompanied by his one student. "They jogged along the bridle path on their horses until they came to a lowly dwelling. They sat a while with a delicate looking girl in whom the ingenuous youth takes a special interest. . . . and so they left the house.

"What thinkest thou, Luke, of the maid we have been visiting?" "She seemeth not much ailing, Master, according to my poor judgment. For she did say she was better. And she had a red cheek and a bright eye, and she spake of being soon able to walk unto the meeting, and did seem greatly hopeful, but spare of flesh, methought, and her voice something hoarse, as of one who hath a defluxion, with some small coughing from a cold, as she did say. Speak I not truly, Master, that she will be well speedily?"

"Yea, Luke, I do think she shall be well, and mayhap speedily. But it is not here with us she shall be well. For that redness of the cheek is but the sign of the fever, which after the Grecians, we do call the hectical; and that shining of the eyes is but a sickly glazing, and

they which do every day get better and likewise thinner and weaker shall find that way leadeth to the church-yard gate. This is the malady which the ancients did call tabes, or the wasting disease, and some do name the consumption. A disease whereof most that fall ailing thereof do perish. This Margaret is not long for earth, but she knoweth it not, and still hopeth."

The logic of latter-day experience affords irrefutable testimony that save under exceptional conditions, no given case of tuberculosis should be pronounced absolutely hopeless. Far-advanced cases of consumption exhibiting marked constitutional disturbances and excessive tissue destruction are sometimes capable of undergoing a complete and enduring arrest. Clinicians whose experience has been confined to the observation of incipient cases in sanatoria may not be inclined to accept this statement, but those who have enjoyed the varied experience rendered possible in health resorts will verify such a conclusion. A few illustrative cases are presented to show precisely what is meant by reported recoveries of cases at first considered to be hopeless.

Case 1.—A woman, twenty-four years old, consulted me May 24, 1902, the day of arrival in Colorado, eight months after recognized symptoms of tuberculosis. There had been progressive rapid failure from the beginning, and a loss of over fifty pounds of weight. She had experienced chills daily, with severe night-sweats, the average afternoon temperature being from 102° to 103° F. The cough was excessive and the expectoration, which contained numerous bacilli, amounted to four ounces during the twenty-four hours. Dyspnea was marked, and the pulse ranged from 120 to 140. Upon examination there was found extensive infection of both lungs; in the left, signs of consolidation with fine moist râles after cough from the apex to the fourth rib in front, and to the very base behind; in the right, numerous fine clicks from the second interspace to the base in front, and from the middle of the interscapular space to the base in the back.

On account of the extensive pulmonary involvement, the great emaciation, the long-continued sepsis, and an irritable, nervous temperament an absolutely unfavorable prognosis was rendered. The urgency of the case was such that cardiac stimulation was employed constantly, and upon several occasions I was constrained to believe that she would not survive twenty-four hours. With a beginning diminution of fever and circulatory disturbance, at the end of six weeks there gradually developed increase of appetite, digestion, strength, and weight, with lessening of cough and expectoration. Following a progressive improvement during a period of two years the patient was discharged as an arrested case and permitted to return home, having gained forty-three pounds in weight. There was no cough or expectoration and the pulse was uniformly under 80. Physical examination at that time disclosed no evidences of existing tuberculous infection. There had resulted, however, extensive proliferation of fibrous tissue throughout the infected areas, giving rise to appreciable changes in the pitch and quality of respiratory sounds without râles.

She has remained at home over five years, and last advices show no evidence of retrogression, in spite of the fact that she has given birth to two children since she left Colorado.

Case 2.—A woman, thirty-five years old, arrived in Colorado in April, 1899, nearly five years after the recognized onset of her pulmonary

infection. There had been a loss of fifty-five pounds in weight; the cough was distressing and paroxysmal, with daily high fever and a pulse varying from 130 to 160 at rest. She was unable to sit up in bed and for weeks nourishment had been taken through a tube. Upon examination there were found signs of extensive active tuberculous infection of each lung; in the right upper front a cavity the size of a small orange, surrounded by consolidation which extended to the fourth rib, and in the back to the lower edge of the scapula; in the left, consolidation from the apex to the third rib and to the middle of the interscapular space. Throughout this entire region moist bubbling râles were recognized on easy respiration.

A hopeless prognosis was made without qualification. The family physician who accompanied her to Colorado stated that she could survive but a week or ten days at the most. She was kept in bed in the open air for nearly six months, with liquid nourishment and nutritive enemata for two months. She remained under my constant observation for two years, during which time she exhibited a slow, but remarkable, improvement. During the first six months in bed she gained fifty pounds in weight, with a corresponding improvement in her general and pulmonary conditions. At the time she was discharged there was a gain of nearly seventy pounds in weight, but with a slight persisting bronchial cough. There was no moisture recognized upon physical examination, though fibrous tissue changes were quite pronounced. She moved to a remote part of the State and continued to maintain her improvement until she died, two years ago, of acute appendicitis.

Case 3.—A woman, twenty-nine years old, arrived in Colorado February, 1898, two years after developing pulmonary tuberculosis. During this period she progressively declined in all respects. There were great emaciation, daily elevation of temperature, weak, rapid, and irregular pulse, distressing paroxysmal cough, and copious expectoration with very numerous bacilli. Examination disclosed evidence of an active process involving a large portion of each lung. In the upper right lung in front there was a cavity the size of an orange, in the midst of an area of consolidation, with numerous bubbling râles from the apex to the fourth rib, and in the back from the apex to the very base. On the left side there was consolidation with moist râles from the apex to the third rib. Moisture was recognized in the left axilla, and in the back from the apex to the lower third of the interscapular space.

On account of the extensive pathologic change, pronounced dyspnea, irritable pulse, hysteric temperament, poor appetite, and frequent vomiting, an ultimately hopeless prognosis was entertained without reserve, which opinion was indorsed by Dr. Babcock, who saw the patient shortly after her arrival in Denver. She has remained under my personal observation during a period of ten years. During the first three years very little change was noted, either in the general state or in the condition of the lungs. The cough was frequent and exhausting, expectoration copious, and bacilli numerous. During the fourth year a beginning improvement was observed in the general condition, the physical signs remaining practically stationary. During the fifth year a gain of fifty pounds was made in weight, followed by an astonishing improvement in every respect. During the past five years she has maintained an excellent nutrition and gained remarkably in strength.

For nearly four years there have been no bacilli found in the sputum after numerous examinations. There is a persisting bronchial cough at intervals, with occasional expectoration. The examination of the chest shows no indication of an existing tuberculous process, although fibroid changes are readily detected.

Case 4.—A young man, aged nineteen, consulted me in May, 1899, his illness having developed ten months previously as an acute pneumonia involving the major portion of the left lung. The patient was sent originally to Las Vegas, New Mexico, in company with a physician and trained nurse, and two months later to Arizona, Koch's tuberculin being used daily for a prolonged period. Following an initial gain while in the Southwest there ensued a persistent elevation of temperature, loss of weight and strength, followed by several recurring hemorrhages. Upon arrival in Colorado there was a loss of thirty-two pounds in weight, the temperature was 104° F. in the afternoon, and the pulse rarely below 120. Numerous bacilli were found in the sputum. There were signs of massive consolidation in the left front from the apex to the fifth rib, with moist râles throughout, and semidry clicks in the left axilla. In the back, bubbling râles were heard to the very base, with an area of well-defined consolidation extending from the apex to the middle of the interscapular space. On the right side there was slight consolidation at the apex, with moist râles to the second rib, and scattered areas of infiltration with moisture throughout the front. Fine clicks were heard in the right interscapular space.

In view of the age, the active advanced process in one lung, the more recent invasion of the other, the hemorrhagic tendency, persisting fever, and rapid pulse, the prognosis could scarcely be other than unfavorable. There developed, however, a gradual resolution of the consolidated areas, and a lessened activity of the tuberculous process, as shown by the slighter amount of moisture, diminution of cough and expectoration, fewer bacilli, and increase of weight and strength. Three and a half years ago, after five years' constant medical observation, the patient had gained nearly sixty pounds, and there was entire absence of cough and expectoration. Examination of the chest failed to disclose any tuberculous activity whatever, there remaining only a somewhat prolonged high-pitched expiration, tubular in quality at the left apex, without moisture. During the past three years he has resided much of the time in Illinois. At present, nearly nine years after coming under my observation, the arrest is complete.

Case 5.—A boy, nine years old, arrived in Colorado June 1, 1903, exactly three months after the development of acute bronchitic symptoms. Following the initial onset he remained eight weeks in bed with a persisting fever and moderate cough. At the end of two months, accompanied by his parents and family physician, he went to New Mexico, remaining thirty days. During this period there had been a progressive rapid decline. At the time I saw him he was greatly emaciated, weighing exactly fifty pounds. His average afternoon temperature was 101.5° F.; there was marked dyspnea on exertion, the appetite was exceedingly poor, pulse 124, and there was a persisting cough without expectoration. There were signs of consolidation throughout the entire left lung, with moist râles upon easy respiration from the apex to base, front and back.

In view of the age, the history of the development of an idiopathic

pleurisy, undoubtedly tuberculous, the continued fever, the great emaciation, and physical signs, an unfavorable prognosis was rendered. The exclusive care of the child was committed to a trained nurse, and an unbroken regimen was maintained for a period of two years and one month. During this time the child exhibited most remarkable improvement in spite of the fact that at the end of four months he contracted a typhoid fever which was of eight weeks' duration, and was followed in the second year by an acute fulminating appendicitis, operated during the first twenty-four hours. He was discharged as cured in June, 1905, there being not the slightest trace of moisture recognized after repeated examinations of the chest, although fibroid tissue proliferation was extensive. His general condition was excellent in all respects, his weight approaching eighty pounds. He has remained well ever since.

Case 6.—A man, forty-one years old, came to Colorado in September, 1904, nine months after an acute pneumonia, which was followed by severe persisting cough and continued fever with night-sweats. In the mean time he had experienced a severe hemorrhage and lost much weight and strength. The sputum had been loaded with bacilli. He had gained eighteen pounds in a well-known health resort, but exhibited persisting elevation of temperature, with occasional chills and severe sweats. Although remaining in bed during day and night for months, there was subsequent loss of weight, with increased cough and expectoration. The condition of the patient was pronounced entirely hopeless by an eminent physician. Upon arrival in Colorado examination of the chest disclosed extensive active tuberculous infection of each lung. On the right side moist râles were heard in front to the third rib, and in the back from the apex to the very base. On the left side there was well-marked consolidation in the upper portion, with but slight moisture in front, but with coarse râles in the back from the apex to the lower angle of the scapula.

A further decline was exhibited during several weeks. The temperature was constantly elevated, chills and night-sweats were frequent, and there resulted greater loss of flesh and strength. The cough was extremely distressing, the expectoration copious, containing numerous bacilli, the temperament markedly nervous, the patient apprehensive and discouraged. The active, widely disseminated tuberculous infection, the unmistakable evidence of sepsis, impaired digestion with entire absence of appetite, the weak and rapid pulse, and the general prostration were sufficient to justify, almost without reserve, an unfavorable prognosis.

After several months a gradual improvement was observed which has continued without interruption. In September, 1905, one year after coming West, there was but little or no expectoration, fever had been absent several months, a gain of forty-five pounds in weight had been established, and the pulse was uniformly of good character. At the present time it is impossible to discover any physical signs attributable to an existing tuberculous process, no moisture being recognized after careful exploration, although fibrous tissue change is marked. The patient has engaged in an arduous legal practice in an unfavorable climate during the past two years, devoting the summer season to rest and recreation in the mountains of Colorado. At the time of his resumption of work examinations of the sputum failed to disclose the

presence of bacilli. They have been discovered at intervals since then, but not invariably.

Case 7.—A young lady, eighteen years old, consulted me in June, 1896, immediately upon coming to Colorado. Her illness was of one and one-half years' duration, during which time she had spent several months in the White Mountains and in Asheville. There were great emaciation and pallor, dyspnea upon the slightest exertion, nausea and daily vomiting with diarrhea, pulse 120 to 130 at rest, cough exceedingly severe, expectoration purulent and copious. Upon examination the entire left lung was found to be involved. There were signs of pronounced consolidation throughout, coarse bubbling râles on easy breathing from apex to base, front and back, with a cavity nearly the size of a fist in the front of the left upper lung.

There was nothing in the history or condition to furnish a warrantable basis for the slightest encouragement. Her age was against her, she was profoundly septic, and her powers of resistance were evidently exhausted. Cavity formation had already taken place, and softening was rapidly going on in a lung partially consolidated from apex to base. She has remained under my observation during the ensuing ten and one-half years. Without entering upon a tedious recital of her detailed progress I will state that during the greater portion of this period she conformed to a strict régime. Resulting improvement was noted from time to time, despite the fact that her circumstances were limited and only absolute necessities permitted. Her eight years of unremitting effort and patience sufficed to bring about a complete arrest. At that time there was but little cough, and the expectoration essentially bronchial in character. She had gained forty-three pounds in weight, had shown no constitutional symptoms for one or two years, and the examination of the chest revealed no evidence of existing tuberculous activity. Examination of the sputum was entirely negative. She was married to an army officer very shortly afterward, and for over a year led the gay and strenuous social life incident to a military post in close proximity to a large city. At the time of her departure for the Philippines I was privileged to make a careful physical examination. In spite of her late hours of social dissipation it was found that there had developed no renewed activity of her former infection. A large cavity persisted in the upper left front without moisture. No râles could be heard in any portion of the lung, which, through the lapse of years, was found to have undergone extensive fibrosis. There was occasional cough, but the sputum was subjected to examination with continued negative results.

In connection with the foregoing reports there are several important facts to be borne in mind: (1) That these cases are selected merely to illustrate the *possibility* of arrest in far-advanced cases, and that other instances of improvement equally striking can be cited. (2) That the cases here described were considered without exception, by other physicians and by myself, as being utterly hopeless by virtue of every consideration which ordinarily influences prognosis. (3) That these patients have not simply undergone improvement with the ultimate outcome as yet uncertain, but, in the process of years, have secured a complete arrest of the tuberculous trouble, with entire absence of physical signs, sputum, and bacilli, and restoration to former usefulness and activity. (4) That the necessity for the practice of strict economy

has been no insuperable barrier to the acquirement of complete arrest in a suitable climate under a proper régime. (5) No claim is made that the results obtained were referable entirely to climatic influences. It is contended, however, that such results in equally desperate cases are impossible of attainment in what may be regarded as relatively unfavorable climates, no matter how perfect the régime. (6) No special methods of treatment were employed other than those familiar to every physician of experience in the management of pulmonary tuberculosis. (7) No credit for results obtained is assumed other than that which may relate to an unremitting personal attention to detail, and an adaptation of means to ends at times somewhat radical. (8) No case is here reported that is not entirely subject to confirmation by the attending physicians, whose names are not cited in the report.

As logical conclusions from such results it may be stated, first, that no physician can assume with positiveness to pronounce death sentence upon any case, no matter how desperate the apparent extremity. Second, that each case strictly on its merits is entitled to a determined, painstaking, and aggressive effort to secure arrest. It follows that while the rich are abundantly able to combat the disease through such means as their medical advisers may counsel, the poor, deprived of such advantages, are justly entitled, at the hands of the State, to adequate hospital provision in an effort to preserve life, rather than to be instructed merely as to the proper method of passing their remaining days.

PART V

COMPLICATIONS

INTRODUCTION

In a book of this character it is particularly desirable to review the various complications observed in the course of pulmonary tuberculosis in the light of their clinical significance. It is not designed to limit the consideration of complications to tuberculous infections of other organs or remote parts of the body, but to include, as well, the intercurrent non-tuberculous affections which exert a modifying influence upon prognosis. From a practical standpoint the coëxisting tuberculous processes in other regions are of especial importance and will be considered in some detail.

Tubercle bacilli may be distributed to various portions of the human system through the medium of the blood-stream; to the pleura, pericardium, lymphatic glands, and certain other regions through the lymph-channels; to the pharynx, stomach, and intestines through the process of ingestion; and to the larynx, in some instances, through direct contact with the expectoration. In the following consideration of coëxisting tuberculous infections the grouping of the various complications is attempted as far as practicable in accordance with their supposed pathogenesis. Through the agency of the circulation as a route of distribution the bacilli are deposited not only in remote and widely separated regions sometimes involving an entire organ or part of an organ, but also are disseminated throughout the body. The general distribution of the bacilli by the blood-stream gives rise to the clinical recognition of what is known as acute miliary tuberculosis.

SECTION I

ACUTE MILIARY TUBERCULOSIS

CHAPTER XLV

GENERAL CONSIDERATIONS

This condition is characterized by the presence, in an infected organ or in many organs, of innumerable, grayish-red tubercles, the size of a millet-seed, which are evidently of simultaneous deposit and exhibit the same degree of development. The present clear conception

of the etiology of miliary tuberculosis has been afforded as a result of the admirable work of Buhl, Sir Astley Cooper, Weigert, Benda, Ponfick, Simmonds, Cornet, Engel, Heller, Eichhorst, and others.

Sir Astley Cooper recognized the existence of tuberculosis of the thoracic duct in 1798. Tubercles have since been found in the duct by Ponfick, Weigert, Koch, Meisels. Brasch, Hanau, Sigg, and Benda.

Weigert demonstrated the existence of tuberculosis of the blood-vessels and its association with miliary tuberculosis.

Tubercle bacilli were found in the blood by Baumgarten, Weichselbaum, Meisels, Lustig, Rütimeyer, and Sticker.

Tuberculosis of the veins was described by Müggе, Schuchardt, Bergkammer, Hauser, Meyer, Will, Heller, Brasch, Banti, Schmorl, Kockel, and others (Cornet).

From the reports of these men it has been definitely established that miliary tuberculosis can result only from the distribution of bacilli through the circulation, and that these microörganisms always gain entrance to the blood-stream from a preëxisting degenerative tuberculous focus, although the latter is sometimes almost impossible of detection. They have shown that a genuine tubercle deposit may take place in the arteries, veins, and thoracic duct as a result of the peripheral extension of adjacent tuberculous foci. In some cases a thickening and obliteration of the finer arteries and veins accompanies the tuberculous extension, while in others, with or without perforation, the bacilli are permitted to enter the circulating fluid through degeneration of tubercles in the wall of the arteries, veins, or thoracic duct. It has been demonstrated that the bacilli do not multiply in the blood. The primary source of infection may be found in a caseating nodule in the lungs, or in a tuberculous focus in the lymphatic glands, the genito-urinary system, bones or joints, pleura, intestines, or peritoneum.

Longcope, in a reported analysis of thirty cases of generalized tuberculosis with especial reference to the thoracic duct as a site of localized infection, introduces interesting data pertaining to the frequency of such involvement in cases of the more acute type, in association with a generally disseminated tubercle deposit in the various organs. In subacute cases the duct was rarely involved, and in chronic cases not at all.

It is easy to understand that the precise distribution of bacilli to various parts of the body must correspond to their point of entrance into the circulation according to the site of vessel-wall infection. If the bacilli only penetrate comparatively small arterial branches, the resulting miliary deposit will be confined to the parts thus supplied. In the event of their entrance into the pulmonary vein, the distribution takes place throughout the systemic circulation from the aorta to the smallest arterial branches. When the bacilli are conveyed to the lungs *via* the lesser circulation, these organs act more or less as a filter, and become diffusely studded with miliary tubercles.

Manifestly, the opportunities for miliary infection should obtain especially in cases of extensive pulmonary tuberculosis, and in this disease a general tubercle deposit occasionally supervenes. In some cases the pulmonary involvement is quite insignificant, suggesting the possibility of its non-relation to the development of the miliary infection. While pulmonary tuberculosis is an important etiologic

factor in the production of miliary tuberculosis, comparatively few cases of consumption are complicated by this condition. That miliary involvement is not of more common occurrence in the course of pulmonary tuberculosis has been the occasion of considerable comment. Certain it is that the clinical manifestations of miliary tuberculosis are observed much less often than would be supposed in view of the unusual opportunities for general infection. This occurs more frequently in early years than in adult life.

Miliary tuberculosis has been reported by some observers to follow frequently the absorption of infected lymphatic glands or the exudate of tuberculous pleurisy or peritonitis. From the observation, however, of a large number of cases of this description I recall but few instances of subsequent miliary involvement. I have noted many times, however, the development of miliary tuberculosis in pulmonary invalids who, though well nourished, were suffering from profound emotional disturbance. Individuals of decidedly nervous temperament are especially prone to this condition, particularly if subjected for prolonged periods to either depressing or exciting influences. I recollect, in particular, a young man with arrested pulmonary infection of over a year's standing, in excellent nutrition, and presenting every physical indication of perfect health, who developed a miliary infection following several months of mental perturbation as a result of financial and domestic embarrassment. My attention has been called to the somewhat unusual frequency of miliary tuberculosis in alcoholic individuals, or in those *previously* accustomed to such overindulgence.

The structural formation and development of tubercle have been discussed in a preceding chapter. The clinical symptoms of general miliary tuberculosis are variable to an extraordinary degree. Notwithstanding the remarkable diversity of clinical manifestations common to this disease, it is possible to group the various combinations of symptoms exhibited in different cases into three fairly distinct classes. These forms of general miliary tuberculosis are designated the *pneumonic* type, because of the predominance of symptoms referable to the lungs and the recognition of definite physical signs; the *typhoidal*, from the close simulation of typhoid fever; and the *meningeal*, by reason of clinical data pointing conclusively toward a cerebral involvement. It is not always possible to differentiate closely between these three varieties of miliary tuberculosis. No matter how clearly defined the early manifestations and how directly suggestive of either the typhoidal or the pneumonic type, a meningeal tuberculosis not infrequently supervenes as a terminal condition. Many cases, however, are distinctly typhoidal, pulmonary, or meningeal from the beginning to the very end. Even among cases closely conforming to any single variety of miliary tuberculosis a very considerable latitude is observed in the combination of clinical symptoms. A purely typical case of, respectively, the pulmonary, typhoidal, or meningeal form is easily the subject of text-book description, but as a matter of clinical observation there are often noticed in the same general class conspicuous differences in the grouping of symptoms. Cases conforming to any of the distinct varieties may be of abrupt onset or they may begin with less defined symptoms. There is also noted a striking variation in the course and duration. Cases of the typhoidal type may be attended with considerable temperature elevation or may be purely afebrile throughout.

The various combinations of symptoms, particularly in the typhoidal and the meningeal forms, are exceedingly numerous, and yet the clinical picture in each instance may be sufficiently characteristic to permit its classification. In a series of cases of meningeal tuberculosis certain manifestations or groups of symptoms may be present in some and entirely absent in others. This is illustrated by the inconstancy of rigidity of the neck, retraction of the head, vomiting, constipation, inequality of the pupils, irregular pulse, retraction of abdomen, changes in the reflexes, spasm, and paralysis.

In spite of the wide range in the clinical data and the incompetency of single symptoms as immutable features of diagnosis, accurate interpretations as to the significance of the varied manifestations are usually afforded. In meningeal tuberculosis it has been found that age exerts an especial influence in determining the nature of the clinical picture, certain combined symptoms unusual in childhood being more or less characteristic of infancy. A single disease capable of producing so infinite a variety of subjective and objective manifestations, when *unaccompanied* by recognizable evidences of pulmonary tuberculosis, must of necessity present *added* difficulties in the way of clinical differentiation and interpretation of symptoms, when developing as a *complication* of an intrathoracic infection associated with more or less systemic disturbance. The early symptoms of general miliary tuberculosis are especially obscure when this condition complicates a preëxisting pulmonary infection. Thus the significance of fever incident to a beginning miliary involvement is entirely lost in a distinctly febrile case of pulmonary phthisis.

One of the chief obstacles to the early recognition of acute miliary tuberculosis relates to the predominance of general symptoms over local manifestations until late in the disease. The systemic disturbances are occasioned by the toxic absorption which takes place a few hours after the entrance of bacilli and soluble poisons into the blood, while the local phenomena are due solely to the formation of tubercles, which are of much later development. Thus it happens that the clinician is often unable to ascribe a definite pathologic significance to preliminary symptoms, and is compelled to approximate his early conclusions upon the basis of combined general manifestations and a review of all possible etiologic factors. The varied combinations of clinical features in miliary tuberculosis are entirely inexplicable, save upon the score of essential differences attending the entrance of bacilli and toxins into the blood-vessels. Widely divergent symptoms in different individuals are dependent upon the site of the original focus of infection, the relative number of bacilli, and the amount of soluble poison introduced into the circulation. According to the location of the eruptive source, the bacilli may find their way directly to the left ventricle and enter the larger circulation for distribution throughout the entire body, or proceed to the terminals of the pulmonary arteries through the intervention of the lungs. In this manner there is exerted to no small degree an influence upon the character of the ensuing manifestations. The number of tubercle bacilli, together with the amount of soluble poison entering the circulation, produce a determining effect upon the severity of the general symptoms and the extent of tubercle formation. Their ingress into the blood-stream is subject to enormous variation according to the size and number of degenerating vascular foci. The entrance of comparatively few bacilli into the cir-

culation from a single eruptive focus may not produce a widely disseminated tubercle deposit, and if not followed by successive crops, may cause clinical disturbances of but temporary duration, sometimes resulting in apparent recovery. It unfortunately happens that in the large majority of cases opportunity is afforded for a renewed discharge of tubercle contents into the circulation from the same focus, and that egress of microörganisms from similar foci often takes place in other parts of the vascular system. This permits a ready explanation of the occasional exacerbation of temperature and other clinical disturbances following such a quiescence of symptoms as to suggest a possible recovery.

Differences in the virulence of the bacilli and toxins introduced into the circulation from an eroded tuberculous area are not without their proportionate influence in characterizing the severity of both the general and the local symptoms. Cornet has called attention to the fact that bacilli discharged from a recent focus of infection are much more active in producing general tubercle formation than the attenuated, broken-down microörganisms from a non-progressive and long-standing tuberculous process. On the other hand, he attributes especial virulence to the soluble poisons accompanying the latter type of bacilli, and a comparatively benign toxic effect to the former variety. Irrespective of the verity of this assertion it would appear that the age of the patient, the previous condition, the degree of emaciation, and the capacity for absorption must play an important part in the severity of the toxic manifestations. Certain it is that the hypothesis as to an increased virulence of the toxemia produced by attenuated bacilli is not borne out by the clinical evidences in pulmonary tuberculosis. In my experience the lesser amount of toxic absorption has usually been observed when the bacilli have shown a tendency toward degeneration and attenuation, and the greater toxemia coincident with the presence of the so-called virulent microörganisms. If this obtains in pulmonary tuberculosis in which the absorption of soluble poisons into the circulation is often slow, it is difficult to comprehend why the same relation should not hold true when the toxins enter the blood-stream directly instead of through the medium of the lymphatics. If this is not the case, general miliary tuberculosis developing in individuals harboring non-active or quiescent lesions with attenuated bacilli would be expected to exhibit a more severe toxemia than in consumptives suffering from rapidly advancing infection. This scarcely is in accord with my personal observations. I have found the general symptoms more marked, as a rule, when the miliary condition complicates an active destructive change. This has been especially true in children in whom the severity of the general symptoms is characteristic, the facilities for absorption more pronounced, and the active virulent nature of the infection strikingly manifest.

Regardless of any fixed relation between the toxic symptoms and the specific characteristics of the bacilli, it is sufficient for present purposes to recognize simply that marked differences exist in the virulence both of the bacilli and of the soluble poisons sufficient to stamp their impress upon the clinical picture. This pathogenic variation in individual cases offers perhaps a partial explanation of the remarkable differences in the clinical course of miliary tuberculosis which otherwise would remain completely inexplicable.

CHAPTER XLVI

THE PNEUMONIC TYPE

General miliary tuberculosis with predominating symptoms referable to the lungs may occur in the midst of apparent health, or it may exist as one of the complications of chronic pulmonary tuberculosis. A preëxisting focus of tuberculous infection is absolutely essential for its development. This form of miliary tuberculosis may begin somewhat abruptly, or the onset may simulate the development of catarrhal bronchitis. The rapid fulminating type with brusque initial symptoms has been described in connection with the acute onset of pulmonary tuberculosis. The first manifestations of the pulmonary variety of miliary tuberculosis may be moderate rigors and other evidences of systemic disturbance, as fever, indisposition, and headache. Attention is early directed to the lungs by cough, dyspnea, and cyanosis. As a rule, the cough is frequent, distressing, and unattended at first by expectoration. The sputum, if present, is of but slight amount, and noticeably thin or frothy in character. Patients sometimes succumb to the malady before the appearance of expectoration. Rarely is it purulent, and then only in the later stages of the disease, when the clinical manifestations clearly show the desperate nature of the condition. Streaks of blood occasionally discolor the expectoration, or it may assume a distinctly rusty hue. Although tubercle bacilli are rarely found in the sputum, the clinical evidences of miliary infection are fairly conclusive. Two of the most important subjective features are the *dyspnea* and the *cyanosis*, both of which greatly exceed the significance ordinarily attached to the physical findings. Sometimes these symptoms are found to precede the cough, the dyspnea in particular often being the first to attract the attention of the patient. In most cases this increases rapidly in association with an aggravation of cough and progressive loss of strength. Some cases are devoid of special cyanosis, but this is quite unusual. The patient is often extremely nervous and apprehensive, but rarely appreciative of the extreme gravity of the condition.

Fever is present only to a moderate extent, the temperature seldom being elevated above 102° or 103° F. Its course is extremely irregular, marked differences of temperature being noted on succeeding days. It is sometimes higher in the afternoon than in the morning, while in other cases the inverse type of fever is displayed. This lack of periodicity in the temperature elevation is often an interesting feature in connection with the disease. High fever usually yields to cold baths, but often rises again after a brief interval. The daily fall of temperature is attended, as a rule, by moderately profuse sweating. Chilly sensations are frequent in the course of the day, either preceding or accompanying the development of fever. The pulse is invariably rapid, soft, and easily compressible, the blood-pressure almost always being found materially reduced. There is rapid loss of flesh and strength, with diminution of appetite and impairment of digestion.

Upon examination the physical signs are apparently trivial in comparison with the subjective evidences of systemic infection and respiratory incapacity. There is rarely dulness upon percussion, save

in the exceptional development of moderately large areas of bronchopneumonia in children. In some cases a general tympanitic resonance is elicited. Upon auscultation, as a rule, no modifications of the normal respiratory sounds are heard, though occasionally a roughening of the vesicular quality is detected. The adventitious sounds, however, are quite characteristic, the *one distinguishing feature* of the physical examination consisting of *innumerable very fine and moist râles.* These are disseminated throughout all portions of each lung, the signs being those of a diffused catarrhal bronchiolitis. The râles may be entirely absent upon ordinary respiration, but are detected readily during inspiration following a short cough. Jürgenson has called attention to occasional friction-rubs of a peculiar soft character, due to tuberculosis of the pleura, and heard both upon inspiration and expiration.

Cases of the pulmonary type, beginning with less acute onset, may simulate for a time the typhoidal form of general miliary tuberculosis. Although the cough may chance to be a subordinate feature, the increasing dyspnea and deepening cyanosis are sufficient to suggest a probable pulmonary involvement, which is subject to confirmation by the physical signs. The course of the disease in most cases is short, the patient usually exhibiting a rapid and uninterrupted decline from the beginning to the end. The duration is seldom longer than a few weeks, although a marked abatement of the previous rapid progress is occasionally exhibited. I have observed a number of cases of undoubted miliary tuberculosis of the pneumonic variety presenting features of decided chronicity. In some cases the disease has assumed a chronic aspect partaking of the essential characteristics of ordinary pulmonary tuberculosis. General miliary tuberculosis, irrespective of its particular type, has formerly been regarded as invariably fatal. Actual recoveries from the pneumonic variety, as well as others to be described, are occasionally reported. I have had occasion to note its stay of execution in several instances, and the adoption of a protracted course, but rarely an apparent complete arrest.

I have under my care at the present time a young man exhibiting characteristic evidences of the pulmonary form of general miliary tuberculosis. His attending physician in a distant portion of the country, in referring the patient for climatic change, wrote: "The bearer, Mr.——— has miliary tuberculosis, having had this condition for about two and one-half months." At the time he came under my observation the history, subjective symptoms, and physical signs were such as to justify an assumption of pneumonic miliary invasion. Exceedingly fine semidry râles were heard throughout both lungs. The dyspnea was entirely out of proportion to the physical evidences. Extreme pallor and physical weakness were apparent. The cough was slight and the expectoration scanty; an occasional bacillus was detected only after long searching. Marked fluctuations characterized a moderate daily temperature elevation. The pulse was very weak, irregular, rapid, and easily compressible. By virtue of continuous rest in the recumbent position the patient has displayed a material gain in weight, with corresponding reduction of temperature. The dyspnea is somewhat less than at the time of arrival. While the ultimate prognosis is at best uncertain, there has taken place a pronounced recession in the severity of the symptoms, suggesting at least the possibility of a further retardation in the progress of the disease.

In striking contrast to the above, the following case is of especial interest, illustrating, as it does, the more frequent clinical course after the advent of a miliary invasion of the pneumonic type.

In 1904 a young man of about thirty years of age, a former patient of Dr. V. Y. Bowditch, was seen in consultation with Dr. C. E. Edson, one month after arrival in Colorado. At the time climatic change was advised the disease had been of comparatively short duration and the general condition was excellent. There had been but little cough and expectoration, nutrition was but little impaired, and the temperature elevation was very slight. The physical signs denoted but an incipient infiltrative process at the right apex. Upon full inspiration following a cough fine clicks were occasionally heard from the apex to the second rib. The condition was, of course, such as to justify an optimistic prognosis. After three weeks' residence in Colorado there developed abruptly a moderate dyspnea, which for a time was incapable of rational explanation. This increased with each succeeding day until, after an interval of a week, the shortness of breath became very pronounced. The dyspnea was accompanied by a moderate dusky discoloration of the face and finger-nails. Much physical debility was exhibited as the air-hunger became more extreme. There was but slight cough, with thin, frothy expectoration. The temperature elevation at no time had exceeded 100° F. Physical examination was negative until the expiration of one week after the onset of acute manifestations. At this time numerous exceedingly fine, semidry clicks were heard throughout all portions of each lung. The râles were very fine, without partaking of a bubbling character, and at first were almost imperceptible. The expectoration gradually assumed a pinkish hue, and later became more definitely blood-tinged. A diagnosis of the pulmonary form of miliary tuberculosis was rendered, together with an unfavorable prognosis. The patient survived less than three weeks, the suffering becoming daily more intense by virtue of the inordinate hunger for air.

This case is particularly instructive as illustrating the development of the pneumonic invasion in the midst of an apparently benign infection, the remarkably rapid decline to a fatal issue, and the striking disproportion between the dyspnea and the physical signs.

CHAPTER XLVII

THE TYPHOID TYPE

The onset of this form of miliary tuberculosis is characterized by the development of vague and indefinite symptoms. In some instances the early manifestations may be decidedly more acute than in others, and include moderate rigors, temperature elevation, and headache. Usually, however, there is a preliminary history of lassitude, physical weakness, and indisposition of from several days' to two weeks' duration. Frequently complaint is made of pain in the head, anorexia, and constipation, the frontal headache being a con-

spicuous feature in very many cases. Often the repugnance to the sight, smell, or even the thought of food is extreme. The patient at first is restless or excitable, but there is manifested a disinclination to physical activity. The sleep is broken by disturbing and usually unpleasant dreams. The tongue may be coated heavily, but the breath rarely assumes the offensive odor characteristic of typhoid fever. There is moderate elevation of temperature, with frequent morning remissions and evening exacerbations, as in typhoid, but the fever, as a rule, does not attain so high a point as in the latter disease. A factor of vital importance is its variable atypical course, even an afebrile condition being no contraindication of the possible existence of miliary tuberculosis. While in exceptional cases the fever is absent altogether, it sometimes is higher in the morning than at night, thus conforming to the inverse type. In the same individual upon different days the exacerbations of temperature elevation may take place either in the morning or at night. The distinguishing characteristic of the fever is its extreme irregularity. The atypical curve is strongly suggestive of miliary tuberculosis in contradistinction to typhoid fever, but a temperature conforming closely to that of typhoid affords no insuperable argument against the tuberculous character of the affection. The daily subsidence of fever is frequently attended by moderate perspiration, although this is observed less often than in typhoid. Also the elevated temperature is decidedly more responsive to baths or cold sponging. In nearly all cases the pulse is markedly accelerated from the very beginning, rarely declining to under 100, and usually ranging from 110 to 130. It is almost invariably soft, easily compressible, and occasionally dicrotic. As the disease advances, the respirations are likely to be more rapid than in typhoid fever, although often incapable of satisfactory explanation from the results of physical examination. In later stages the characteristic Cheyne-Stokes type of breathing not uncommonly makes its appearance. Cough may be present in typhoid fever as an initial symptom, and develop later in the course of the disease on account of a concurrent bronchopneumonia or hypostatic congestion. This may be confused with the frequent distressing cough which sometimes constitutes a clinical feature of miliary tuberculosis. This symptom, together with dyspnea and cyanosis, is particularly characteristic of those cases in which the typhoid type of the disease gradually merges into the pulmonary. Nosebleed is sometimes observed as in typhoid, though less frequently. Neither its presence nor its absence should be regarded as especially suggestive of the nature of the disturbance. The headache is subject to considerable variation in each disease. It is usually more severe in miliary tuberculosis, and is likely to increase in severity rather than the reverse, as in typhoid. Early in the course there may exist the same restlessness and nervous excitability and subsequently mental hebetude, drowsiness, stupor, and finally delirium or coma. In miliary tuberculosis there is often exhibited at different times a striking variation of the mental condition in the same individual. The patient, upon being aroused from a moderate stupor or even a heavy sleep, may regain full possession of the faculties for the time being, only to lapse into a drowsy indifference when the attention is withdrawn. A mild delirium in like manner may give way to a rational coherence of thought and utterance for a brief period. These abrupt changes in the mental status no doubt are occasioned in part by differences in the degree of toxic

absorption, and are somewhat suggestive of tuberculosis. The muttering delirium and singultus coincident with profound stupor, though present at times, are probably observed less often than in typhoid. Herpes is rarely present in typhoid, but is noted frequently in the early course of acute miliary tuberculosis. Rapid loss of flesh and strength are characteristic of the two conditions. Generally speaking, the flushed face of typhoid is contrasted with the pronounced pallor which usually accompanies miliary tuberculosis, especially during the afebrile period. Diarrhea and meteorism may be present in each disease, and the abdomen may be either retracted or distended. Rose-spots, though regarded as a distinguishing feature of typhoid, are sometimes present in miliary tuberculosis. The spleen is enlarged to a greater extent in typhoid, in which condition it is almost always palpable. Leukocytosis may be detected in miliary tuberculosis, rarely in typhoid. The diazo-reaction may be recognized in both conditions, and has, therefore, but slight diagnostic value. Albuminuria, while sometimes observed in typhoid, is more often present in miliary tuberculosis. In this condition tubercle bacilli are reported to have been demonstrated in the blood, but while their presence is undoubtedly of positive value, their absence possesses no negative significance. In like manner recognition of choroidal tubercle is conclusive evidence of miliary tuberculosis, but its absence on repeated examinations does not negative the existence of the disease. The Widal test is of the utmost value, and may be regarded as definitely decisive of typhoid. The presence of tubercle bacilli in the cerebrospinal fluid, as demonstrated by lumbar puncture, also offers incontrovertible evidence of a miliary invasion.

It is beyond dispute that some cases do not admit of positive diagnosis until the autopsy findings are disclosed. Provisional information is furnished by the prevalence of a typhoid epidemic in the immediate neighborhood, the existence of tuberculosis in the same household, or the history of important predisposing causes. Thus coëxisting or antedating pulmonary tuberculosis, enlarged lymphatic glands, tuberculosis of bones and joints, idiopathic pleurisies, or in children a recent whooping-cough or measles, would suggest a general miliary tuberculosis on account of the recognized facility for general infection. Even in doubtful cases an accompanying tuberculous process in other parts of the body does not offer conclusive evidence of a general bacillary invasion. Pulmonary invalids are quite as likely to contract typhoid fever as non-consumptives, but the presence of bacilli in the sputum at least strengthens to a considerable extent the theory of a general infection. It must not be understood, however, that a negative history of tuberculosis in association with other symptoms precludes the possibility of miliary tuberculosis.

Attention to the above features of differential diagnosis suffices for the accurate determination of the condition in the great majority of cases, although in some instances a definite conclusion is quite impossible during life. As a rule, failure to establish a correct diagnosis in cases of this type of miliary tuberculosis is not occasioned so much by reason of any lack of credible data for this purpose, as through neglect on the part of the physician to utilize properly the means which are available. A single instance from my recent experience is cited for the sake of illustration.

I saw, in consultation with a prominent and respected member of

the profession, a man of forty-five years, who was stated to have been suffering from typhoid fever for three months. In the absence of a prevailing epidemic the physician in charge had made the diagnosis during the first week of his illness upon the basis of headache, fever, general indisposition, and repugnance for food. Throughout the entire period of illness the physician extended assurances that defervescence must shortly be established. The medical attendant asserted that he had been privileged to observe nearly 1000 cases of typhoid fever, and that the accuracy of the diagnosis was beyond question. Upon preliminary inquiry I elicited the information that there had been no nosebleed, no enlarged spleen, no rose-spots, and that the Widal test had not been employed. The examination of the fever-chart disclosed an irregular, jagged line of temperature elevation. During most of the time there were morning exacerbations and evening remissions, followed by excessive perspiration. The tongue had not been coated at any period of the disease. At no time was the intellect clouded to the slightest degree. It was apparent, even before seeing the patient, that the diagnosis of typhoid fever was almost untenable. It developed that the invalid several years before, had been pronounced an arrested case of pulmonary tuberculosis. Upon examination the evidences of general miliary tuberculosis were of a very suggestive character, and a definite suspicion was entertained as to a threatening meningeal invasion. Two days later the patient developed a sudden apoplectiform attack, resulting in profound coma from which he never emerged.

This case is rather a striking commentary, not upon the difficulties in the way of accurate diagnosis, but upon the ease with which vital clinical data may be overlooked.

The course of this form of miliary tuberculosis is exceedingly variable, the duration extending from ten days to several months. In the more acute cases the progress may be sufficiently rapid to produce death within one or two weeks. Such fulminating cases are not uncommon. Others, after a variable period, exhibit the symptoms and signs of pulmonary involvement, *i. e.*, the increasing rapidity of the respirations, the cough and cyanosis, the Jürgenson friction-rub, and the fine râles of diffuse bronchiolitis. Death may be hastened by the pulmonary invasion or by the onset of meningeal complications. Recovery from miliary tuberculosis has always been regarded as extremely rare, if not altogether impossible, but authentic cases have occasionally been reported. From my own experience I can recall several exceptional instances of recovery from supposed miliary tuberculosis of the typhoid type. I have in mind a patient who, eleven months ago, exhibited in another State apparent evidences of miliary invasion, although the condition was at first regarded by attending physicians as typhoid fever. After the lapse of two months the extreme prostration was followed by the characteristic physical and bacteriologic manifestations of pulmonary involvement. The severity of the general symptoms finally showed signs of abatement and the patient exhibited sufficient improvement to justify his removal to Colorado. Upon arrival there were physical evidences of a disseminated tubercle deposit involving a large portion of both lungs, very fine moist râles being recognized in the absence of appreciable consolidation. The pulse and respiration were both rapid. Complete rest in the open air during a period of six months has been attended by a gain of fifteen pounds in excess of the normal

weight, and by a gradual reduction in the rate of the pulse and respiration. Complete absence of subjective symptoms and a negative physical examination constitute in this case the final result of an initial condition, which was presumably miliary in character, though not subject to absolute confirmation. Not infrequently cases of pulmonary tuberculosis have been observed whose origin was referred by attending physicians to a miliary infection of the typhoid type. I have not been convinced that it has been *invariably* more difficult to secure improvement in cases presenting such history than in those of chronic ulcerative phthisis. This anomalous experience is to be explained largely by the fact that cases of miliary tuberculosis conforming to the typhoid variety, as a rule, are not permitted to seek change of climate until the beginning of favorable manifestations. It, of course, cannot be contended that in general, chronic consumption originating from general miliary tuberculosis is as hopeful as ordinary phthisis.

CHAPTER XLVIII

THE MENINGEAL FORM

Pathogenesis.—The meningeal variety of miliary tuberculosis consists essentially of an inflammation of the pia mater resulting from bacillary infection. The condition was known as acute hydrocephalus, dropsy of the brain, granular meningitis, or basilar meningitis, long before its precise origin was recognized. It may be assumed in all cases to be secondary to a preëxisting tubercle deposit in other parts of the body. Although it is sometimes impossible to discover antecedent tuberculous processes at autopsy, such failure does not establish the existence of this condition as a primary infection. It has been suggested that the original bacillary invasion may take place through the nostrils and the cribriform plate of the ethmoid. While it is unnecessary to attempt to controvert this possibility in very exceptional instances, it may be accepted as true that, in the vast majority of cases, the meningeal infection is secondary to a primary, though perhaps undiscoverable, focus elsewhere. It is often comparatively easy to recognize tuberculous processes of undoubted priority, in the lymph-glands, bones, joints, lungs, larynx, kidneys, bladder, genital organs, intestines, and middle ear. Meningeal tuberculosis may occur at almost any time of life, though rarely during the first year, and infrequently in old age. As a rule, it is more difficult to ascertain upon postmortem examination the precise anatomic origin of the condition in young people than in later years. In infants or little children the condition sometimes appears to develop *de novo*, the autopsy findings being entirely negative. Its derivation in early life may be ascribed in many cases to unsuspected tuberculous infection of the mediastinal or mesenteric glands. Among adults it occurs most frequently in connection with readily discoverable pulmonary tuberculosis. Although this disease furnishes a primary source of infection for many cases of meningeal tuberculosis, comment has been made upon the fact that the latter complication is not of more

frequent occurrence. The wonder is that, with the innumerable opportunities for blood-vessel tuberculosis in pulmonary phthisis, miliary invasion does not take place far more often than is actually the case. An interesting and somewhat singular clinical phenomenon is the lack of relation between the extent or degree of activity of the pulmonary process and the probable occurrence of meningeal infection. Meningeal tuberculosis is quite as likely to result in connection with quiescent cases of pulmonary tuberculosis as with those exhibiting an active infection and extensive destructive change.

I have frequently observed the development of this complication among pulmonary invalids who presented every indication suggestive of a favorable issue. I have been compelled to witness its occurrence even among patients who had been fortunate enough to secure an apparent arrest of the pulmonary infection. A few cases of miliary infection are recalled in individuals who for years had exhibited upon examination every appearance of perfect health, and had pursued lives of physical activity in the open air. Upon the basis of my own observations it is impossible to establish any relation between the activity, duration, or extent of the pulmonary process and the susceptibility to meningeal complications. Certain other conditions seem to possess an undoubted bearing upon the likelihood of future meningeal involvement. Generally speaking, irritable and highly excitable individuals have been found to develop meningeal tuberculosis more frequently than those of phlegmatic temperament. The cheerful and sunny in disposition are less prone to suffer from this complication than the pessimistic and depressed. I have observed its development in numerous cases following a protracted season of severe nervous strain or emotional disturbance. I have in mind a man, thirty-two years of age, in whom the arrest of the pulmonary infection was apparently complete, who experienced unusual mental worry and depression of spirits from a rapid culmination of unfortunate events, including financial reverses, domestic infelicities, and the death of a child. Although nutrition remained unreduced for a time and the appearance was that of remarkable vigor, tuberculous meningitis finally supervened. By a strange coincidence his wife, exhibiting a slight pulmonary involvement and a nervous, irritable temperament, also succumbed to this complication after a period of profound despondency. Although it may be but one of the anomalies of my experience, the history of excessive alcoholism has frequently been associated with the subsequent development of tuberculous meningitis. This disease has been found to be more common in males than in females. Although the greater portion of my patients have been of the female sex, meningeal invasion has not been observed among them nearly so often as among the males. I have seldom witnessed its occurrence in pulmonary invalids over fifty years of age, presumably on account of the lessened opportunities for extension of tuberculous processes at this time of life.

I do not recollect a single instance of its development among the Jews, the negroes, or the Swedes. It has appeared less often among the Irish than might be expected from their mercurial disposition and excitable temperament. The Scotch, Germans, and Americans among my own cases have suffered from this complication more frequently than other nationalities.

The **pathologic changes** in the pia mater are found more often at

the base, though they are occasionally present at the sides and upon the cortex. The tubercle deposit may also take place in the brain substance, the convolutions, the ventricles, and the blood-vessels. The pia may be studded by the eruption of few or numerous miliary tubercles, varying in size from a pinpoint to a small seed. Not only do the granulations vary considerably in number and in size, but also with reference to their location and attending inflammatory disturbance. The tubercles often extend along the course of the blood-vessels, and are present particularly in the reflected interior spaces, such as the fissure of Sylvius, around the optic chiasm, and the anterior and posterior perforated spaces. They are sometimes found upon the lateral surface of the meninges, but rarely upon the convexity of the hemispheres. Considerable difference exists in the amount and character of the inflammatory exudate, which may be of a serous, fibrinous, purulent, or sometimes even of a hemorrhagic nature. In some cases the fluid exudate is slight; in others, comparatively abundant. The upper surfaces of the brain may be distinctly edematous, or they may be normal in appearance. Flattening of the convolutions is sometimes observed, particularly at the bases. The lateral ventricles are often distended by variable amounts of fluid. Small nodular tubercles may occur upon the arteries of the anterior and posterior perforated spaces. Nodular tuberculous enlargements are found upon the smaller arteries (Osler). Many of these small tubercles in the perivascular sheaths of the smaller arteries are in varying stages of caseation (Collins). The changes in the wall of the blood-vessel may consist of an endarteritis of tuberculous origin with intramural proliferation as a result of the invasion by the bacilli of the blood-stream (Hektoen). Narrowing and obliteration of the finer vessels often take place. Solitary tubercle of the pia occasionally results from the confluence of a large number of miliary tubercles confined within a sharply circumscribed area. In such cases the bacillary invasion takes place through a single small meningeal blood-vessel. These solitary tubercles sometimes attain astonishing size, without producing symptoms suggestive of their presence. This may happen only when the tubercle chances not to encroach upon the area of the brain having jurisdiction over special functions. It is often separated from the contiguous brain substance by an area of granulation tissue (Collins).

The **symptoms** of tuberculous meningitis are extremely diverse in character, the clinical picture being decidedly complex, even among patients of the same age. It is impossible to describe any single type to which all cases may be expected to conform. It is interesting to note that some observers have described the symptoms as exceedingly uniform, while others have regarded them as varied and indefinite. Much confusion results from the fact that the general symptomatology varies within wide limits, according to the period of life during which the disease makes its appearance. To afford greater clearness it is well to recognize essential differences in the mode of onset and course of tuberculous meningitis among adults, young children, and infants, and to avoid any attempt toward an arbitrary classification of symptoms applicable to varying ages. By discriminating sharply between the clinical manifestations at different times of life, the so-called atypical cases are less frequent in actual practice. It is easy to comprehend the many difficulties attending any attempted exposition of a single group of symptoms to be submitted as a single type of the disease, and to appreciate the

innumerable opportunities for error resulting from such effort. It is desired to distinguish between the meningeal tuberculosis of adults, developing in the course of pulmonary phthisis, and the apparently primary infection of children and of infants.

Symptoms in Adults.—Among phthisical patients the clinical manifestations of meningeal invasion are somewhat varied. The onset of this complication during the course of pulmonary tuberculosis may be fairly abrupt in some cases, while in others the beginning symptoms may be exceedingly vague and indefinite. Occasionally the initial manifestations may be entirely subjective in character, and develop with sufficient rapidity to surpass in importance the significance of delayed objective phenomena. At other times the local signs assume an early prominence before suspicion of a meningeal involvement has been awakened by subjective symptoms. The clinical evidences of its development may be obscured to a degree by the fever incident to the pulmonary condition, the muscular weakness and exhaustion, the irritability, digestive disturbance, insomnia, and headache. In the absence of confusing symptoms, however, the existence of a pulmonary lesion, rather than masking the development of meningeal tuberculosis, tends to emphasize the possibility of its occurrence.

The more frequent method of onset conforms to the non-acute type, exhibiting a preliminary period of malaise and apathy, followed by well-defined subjective and objective manifestations. After a short initial period of indisposition there develop lack of appetite, irregularity of the bowels, disturbed sleep, moderate elevation of temperature, and, most important of all, a continuous severe headache. This latter symptom usually increases in intensity until it becomes well-nigh intolerable. The pain, as a rule, is confined to the frontal region, but is sometimes located at the back of the head. It may extend down the neck, which later becomes more or less stiffened. A moderate elevation of temperature is usually found in conjunction with the headache, but the absence of fever offers no contra-suggestion as to the possible coëxistence of meningeal infection. I have observed a considerable number of cases presenting no elevation of temperature at any time during the course of this complication. Gastric disturbances are not infrequent in the early stages, expulsive vomiting, in particular, constituting an important symptom. Headache, fever, and vomiting, if of joint occurrence, and independent of readily assignable cause, are strongly suggestive of meningeal tuberculosis, although, as will appear later, this condition occasionally develops without exhibition of these symptoms. In some cases the intellect remains unimpaired for many days despite excruciating pain in the head and inability to sleep save under the influence of an opiate. Eventually, however, the sensorium becomes clouded and mild delusions take place, followed by increasing stupor, low muttering delirium, and coma.

Another type of onset among adults consists of an early blunting of the intelligence, sometimes without fever, headache, or vomiting. The first intimation of approaching danger is conveyed to the medical attendant by temporary periods of rambling discourse and wandering delirium, with increasing tendency toward heavy and profound sleep. During the greater portion of the day the patient is in evident possession of the mental faculties, complains of nothing, and is disinclined to talk save at the time of brief delusions, which are rarely unpleasant. There

is seldom any apprehension of danger, and consequently no effort to escape from imaginary peril or to inflict injury upon others. The duration of these periods is usually short in the beginning. They appear but infrequently during the first few days, and occur during the night oftener than in the day. These mental aberrations may take place in individuals who have difficulty in sleeping, as well as in those evincing a tendency to drowsiness. After a few days the flight of the intellect becomes more frequent and longer in duration, and is followed in many cases by pronounced stupor. At such a time the patient is aroused with difficulty and presents at first an appearance of sudden bewilderment. Later the invalid may answer questions intelligently and seem entirely rational, though inclined to silence unless closely interrogated. He soon lapses again into a profound slumber, which is sometimes accompanied by distressing moaning, more as if in apparent remonstrance to disturbing visions than from actual pain. The period of transition from these conditions to the state of complete coma, described in connection with the preceding class of cases, is usually brief.

Sometimes the meningeal infection develops with obstinate vomiting or hiccough, which precedes for days all other manifestations indicative of the condition. I recollect one instance in which the onset was so distinctly sudden as to suggest the apoplectiform method of development. In this instance the patient fell to the floor while putting on his clothes, and merged from a short period of consciousness into a state of delirium, with later ocular and motor symptoms, these manifestations persisting to a fatal termination in ten days.

Among some consumptives an early symptom of tuberculous meningitis consists merely of greatly increased restlessness. Such patients are especially apt to suffer from insomnia. The delirium which finally develops in these cases is likely to be acute and maniacal. Among these patients loud screaming, both by day and night, is not infrequent. The delusions are those of danger, and the clinical picture is not markedly dissimilar to delirium tremens. Tremor and muscular twitchings of the face and extremities are sometimes observed. Several times I have noted the first manifestations of approaching meningeal tuberculosis to be tremor and twitching of the extremities in the absence of all subjective symptoms.

Other objective signs may appear long in advance of headache, fever, vomiting, or impaired intellect. Inequality and irregularity of the pupils may be the first indication of impending meningeal involvement. I have occasionally observed a gradually increasing paralysis of an arm and leg before the exhibition of other subjective or objective symptoms. Ocular and motor signs, however, do not supervene, as a rule, until after the subjective manifestations have become fairly well defined. At such times there may be noticed inequality of the pupils or dilatation, strabismus, conjugate deviation, optic neuritis, and ocular palsies. Choroidal tubercle is sometimes recognized. The stiffness of the neck becomes marked, and the head greatly retracted. There may be monoplegia or hemiplegia. In some cases tetanic contraction of a limb may take place. Kernig's sign is usually present, consisting of failure to extend the leg upon the thigh, which is in turn flexed upon the abdomen. The pulse may be slow, and of high tension, or rapid and irregular.

The duration is variable, death taking place within a few days,

or the course may be protracted throughout a period of many weeks. There is frequently observed a relation between the manner of onset and the subsequent type of the disease, cases with initial acute symptoms usually pursuing a violent and rapid course. It sometimes happens, however, that even cases with insidious onset later develop acute symptoms and terminate abruptly. It will be seen that the general clinical picture of meningeal tuberculosis, even among adults, is subject to great variation.

Symptoms in Children from Two to Six Years of Age.—At this period of life the early symptoms are always subjective rather than objective in character. The onset may be comparatively sudden, with violent manifestations, or the acute symptoms may be preceded by a prodromal period of one or two weeks' duration. In some cases they are shortly antedated by a fall or by an acute infectious disturbance, as measles, influenza, or whooping-cough. These premonitory symptoms are more or less ill defined, and consist of impaired appetite, pallor, loss of weight, peevishness, irritability, disturbed sleep, and sometimes a perceptible change in disposition. Severe gastro-intestinal disturbances often accompany the onset. There may be a slight irregular elevation of temperature in the very early stages. As a rule, there is not noted any invariable change in the character of the pulse at this time. The early attention of the parents is attracted chiefly to the restlessness and appearance of fatigue, with pallor and emaciation. Usually by the end of a week more acute symptoms are observed. Vomiting is very common, is occasionally expulsive in character, and often has no connection with the ingestion of food. The temperature is found to be moderately elevated, and the child is seen to put the hand to the head as if in pain. Headache is the most important symptom concerning which complaint is made. This, with vomiting and fever, often independent of prodromal manifestations, is sufficient to awaken suspicion concerning the possible nature of the condition. The disquietude of the physician is much intensified if these symptoms are found to supervene immediately after the prodromal manifestations which have been described. In some cases the onset may be still more abrupt, the first symptoms referable to the condition consisting of convulsions, which may recur at intervals.

After the lapse of several days the general symptoms become more pronounced. The rate of the pulse is not accelerated, as a rule, but is often irregular. A slow and irregular pulse in connection with other symptoms is of much importance in diagnosis. While fever is not always present, the temperature in most cases is elevated to a moderate extent, but seldom is there observed any distinct periodicity attending its rise. There is often fever at one hour of the day and a normal or subnormal temperature at other times. It is sometimes present in the morning and absent in the afternoon. In some cases the fever is continuous for several days, and is followed by a brief recession, only to rise subsequently in the course of the disease. Occasionally the respirations are irregular and even sighing in character, but change in this respect is not a factor of especial clinical moment. The restlessness, pallor, loss of strength and weight progressively increase. The child becomes extremely irritable, and cries upon the slightest provocation and often without any assignable cause. The least change in the position of the patient is usually sufficient to provoke a scream, which appears to be

occasioned by pain in the head. A sudden jar in the room, as the closing of a door or window, falling of a book, moving of a chair or the bed, adjusting the clothing or even a window-shade, may disturb the child and incite a pitiful cry. The screaming, however, is often independent of external causes, and occurs, as a rule, in paroxysms, which are followed by lulls of short duration. In exceptional cases it becomes continuous until the child is relieved by opiates. The cry, which is of peculiar character, is regarded as especially suggestive of tuberculous meningitis, and for many years has been described as the hydrocephalic cry. The facial appearance of the child is often quite as characteristic as the cry, though extremely difficult of description. The features are more or less drawn and pallid, the expression anxious and appealing. In early stages nothing remarkable may be noted in the eyes, but on account of the emaciation, they may appear to be unusually large. The pupils may be contracted, dilated, unequal, or show no change whatever. It is not uncommon to find them equally contracted at this time. Sleep is short and fitful, may be accompanied by moaning, and is often interrupted by sudden screams, the child apparently awakening in extreme terror. Twitching or jerking of the extremities is frequently observed during sleep. Physical examination early in the course of the disease is negative, objective signs not being discovered, as a rule, until the irritative stage has passed. As the disease advances the acute signs of irritation subside to a great extent, and the child becomes dull and heavy. Headache no longer is complained of, and the screams materially diminish in frequency and severity. There develops, on the other hand, a distinct apathy with indifference to surroundings. Noises cease to disturb, sleep is profound, and it is often difficult to arouse the patient. Delirium sometimes supervenes. The bowels are constipated, and the abdomen retracted in many cases.

Considerable importance has been attached by some observers to the existence of the *tache cérébrale* upon the skin of the abdomen, but its import has been greatly exaggerated. The vomiting is now less frequent, and may disappear altogether. The patient no longer is able to sit up in bed unless supported, and is inclined to rest quietly upon the side. The head may become noticeably retracted, and the neck stiffened to an appreciable extent. Inequality of the pupils may now be noticed, together with strabismus. Ptosis and nystagmus may exist, and the pupils may not react to light. Kernig's sign, previously described, is possessed of great diagnostic significance. Babinski's sign is also of considerable importance, consisting of extension of the great toe, instead of the normal flexion upon scratching the sole of the foot. In the last stages of the disease the symptoms are not especially different from those already enumerated in connection with meningeal tuberculosis of adults. The stupor increases to the point of coma. After this has become established, consciousness is rarely, if ever, restored, although the child may linger for many days. Moaning or muttering delirium during the comatose state is less often observed in children of this age than in adults. From my own observation I am inclined to think there is less tendency toward picking of the bed-clothes or waving of the hand in front of the face. Conjugate deviation is often noted, and optic neuritis not infrequently occurs. The ghastliness of the picture is increased by the upturned eye-

balls and the partially closed lids. Retraction of the head becomes more pronounced. Twitching of the facial muscles sometimes takes place, together with spasmodic contractions of the limbs of one side. Complete paralysis of certain parts may develop—frequently an arm and a leg of the same side. The pulse is now extremely rapid, and dissolution appears very imminent. It is surprising, however, how long the patient may persist in an apparently moribund condition. Several times I have seen a week or ten days elapse after the development of coma before death.

Symptoms in Infants.—An essential difference between the symptoms of meningeal tuberculosis in infancy and childhood is the more sudden onset in the former, and the greater frequency of initial convulsions. It has been stated by certain observers that some of the important features in the differential diagnosis of meningeal tuberculosis and cerebrospinal meningitis are the more sudden development in the cerebrospinal cases, the greater violence of the symptoms, and the shorter duration of the disease. This relation hardly obtains in the meningitis of infants, as the onset of meningeal tuberculosis in such patients is often extremely abrupt, and the course short and violent. On the other hand, the development of cerebrospinal meningitis is sometimes slow and indefinite, with a subsequent protracted course. Morse has recently called attention to this interesting comparison in a class of forty cases of meningitis in infancy, equally divided between the tuberculous and the cerebrospinal forms. His diagnosis was made in each instance by autopsy or lumbar puncture. The duration of the disease in his tuberculous cases varied from one to forty-four days; in the cerebrospinal, from seven days to six months. The majority of the tuberculous cases lasted from six to fourteen days, and the cerebrospinal, from seven days to several weeks. A slow pulse is somewhat less likely to be observed in infancy than in childhood, as is also a slow respiration. The so-called stage of irritation is also shorter as a general rule.

Initial restlessness is less pronounced, while apathy, stupor, and unconsciousness develop earlier. I am inclined to believe that strabismus is more frequent in infants than at a later time of life. The fontanel may be closed, level, or elevated in meningeal tuberculosis of infants, or may vary from time to time. Morse especially emphasizes, in his analysis of cases, the marked similarity of the symptoms in the meningeal and cerebrospinal forms. Aside from the fact that the general condition of the patients was somewhat better in the cerebrospinal variety of meningitis, no very essential difference was noted in other symptoms. The temperature, pulse, respiration, gastro-intestinal disturbances, pain, convulsions, condition of eyes and abdominal muscles were practically the same. While the rigidity of the neck and retraction of the head, as well as paralysis and spasm of the extremities, were somewhat more constant in the cerebrospinal cases, no important differences sufficient to justify a differential diagnosis were observed. Among other symptoms common to the two diseases in infants were noted rapidity of the pulse and respiration, the relative infrequency of excessive vomiting, constipation, and manifestations of pain.

Differential Diagnosis.—Koplik has completed an analysis of fifty-two cases of tuberculous meningitis, the diagnosis being con-

firmed by lumbar puncture, autopsy, or animal inoculation. He emphasizes the significance of low temperature, the absence of hyperesthesia, of herpes or petechiæ, the presence of optic neuritis or choroidal tubercle, and the importance of skull percussion for the detection of hydrocephalus. From the reports of most clinical observers it would appear that in tuberculous meningitis the temperature is seldom elevated to a marked degree, particularly in early stages, while cerebrospinal meningitis, especially the epidemic form, is characterized by an abrupt onset and high fever.

The meningeal tuberculosis of babies, however, fails to conform to the type of symptoms in childhood, which has often been assumed to represent the standard for all cases in early life. Differential diagnosis between *tuberculous* and *cerebrospinal* meningitis in infancy is practically impossible upon the basis of the clinical symptoms, and can be determined with accuracy only by examination of the cerebrospinal fluid obtained by lumbar puncture. An excess of mononuclear cells is characteristic of the tuberculous form, while a predominance of polynuclear cells suggests the probability of the cerebrospinal variety. Tubercle bacilli and meningococci are sometimes discovered. The history of exposure to tuberculous infection affords provisional evidence as to the nature of the disease. There is no condition presenting greater opportunity for errors of diagnosis than meningeal tuberculosis in infants. From a considerable experience with such cases and other affections closely simulating this disease I am impelled to urge the withholding of a positive diagnosis prior to the performance of lumbar puncture. No matter how desperate the condition or how apparently conclusive the diagnosis upon the basis of the subjective and objective signs, its unreliability has been demonstrated all too frequently by an experience not altogether agreeable. It is inadvisable to withhold indefinitely from the family the nature of one's suspicions regarding the gravity of the condition, but it is often inexpedient to render an absolutely unqualified diagnosis. The medical attendant may occupy but few more unpleasant positions than obtain when presuming to diagnose and prognosticate unfavorably a case of supposed meningeal tuberculosis, which eventually proceeds to complete recovery. The evidence is irrefutable either that other conditions so closely simulate meningeal tuberculosis in infants as to preclude a positive diagnosis save on the basis of lumbar puncture, or that a few cases of tuberculous meningitis unquestionably recover. The opportunities for error in diagnosis were much greater in former years than at the present time, when the medical attendant is privileged to utilize such diagnostic aids as the Widal test for typhoid, the recognition of the malarial plasmodium, the determination of leukocytosis, the culture test for influenza bacilli, and examination of the cerebrospinal fluid for lymphocytes and tubercle bacilli in tuberculous cases, and for meningococci and polynuclear cells in the cerebrospinal variety.

Young children previously living in *malarial* regions, upon removal to northern localities, have been known to present symptoms at first strongly suggestive of meningeal tuberculosis. It is often possible in such cases to recognize, upon close observation, a certain periodicity in the temperature elevation. All doubt, however, may be removed by the examination of the blood.

There is no condition so frequently mistaken for meningeal tuber-

culosis as *typhoid fever*. In many cases it is impossible, upon the score of the general symptomatology, to differentiate accurately in infants between this disease and meningeal tuberculosis. In cases of typhoid complicated by actual meningitis or characterized by functional or toxemic meningeal disturbance the diagnosis is well-nigh impossible unless the medical attendant takes advantage of such special diagnostic methods as examinations of the blood and the cerebrospinal fluid. I recollect a case seen in consultation some twelve years ago. The patient was an infant between one and two years of age. A diagnosis of typhoid fever had been made by an unusually skilful clinician. The consultation occurred late in the afternoon, the child not having been seen by the medical attendant since morning. In the mean time the condition had grown progressively worse, and the child had lapsed into unconsciousness. The patient was found lying upon the side, with the head much retracted, the neck extremely rigid, and presenting other symptoms characteristic of meningeal tuberculosis. In view of the complete transformation in the clinical appearance, the medical attendant was quick to reverse his diagnosis, and stated to the family that the condition was one of unquestionable tuberculous meningitis and hence entirely hopeless. It appeared from the available evidence: first, that the symptoms were precisely typical of meningeal tuberculosis, and that perhaps the preponderance of evidence pointed toward this disease; secondly, there were no methods of precision to establish beyond all possible doubt that the condition was not, after all, typhoid fever. Inasmuch as I had previously observed similar cases presenting almost conclusive evidence of meningeal tuberculosis which subsequently proved to be typhoid, it was apparent that although there was every reason for the utmost concern whatever the diagnosis, it was quite impossible to affirm absolutely that the condition was meningeal tuberculosis and necessarily fatal. Accordingly, I declined to offer a positive diagnosis both on account of the practical correctness of this position, and also because it appeared that if there was the slightest reason for doubt, the grief-stricken parents were entitled to the faint hope arising from a withheld opinion. This view seemed to be correct, and was based upon the fact that many times the unexpected is found to happen. A few hours later an eminent neurologist saw the patient in my absence, and made an unqualified diagnosis of tuberculous meningitis, and refused to concede the remotest possibility of other disease or of recovery. The child, after lingering apparently in a hopeless condition for several days, finally displayed typical symptoms of typhoid fever, from which he eventually recovered. The case is cited to illustrate not only the difficulty, before the days of special aids, in differentiating accurately between meningeal tuberculosis and typhoid fever in infants, but also to emphasize the expediency of reserving a positive opinion in cases of possible doubt.

The toxemia of *pneumonia* is sometimes so great as to produce symptoms distinctly referable to the meninges. In little children there is often absence of cough, and the sudden onset may be characterized by a convulsion. The elevation of temperature, the early restlessness, and the speedy development of drowsiness and coma at times may closely simulate meningeal tuberculosis. Errors of diagnosis may be avoided only by detailed examination of the chest. In such cases careful search must be made for small localized patches of pneumonia, which

are often separated from one another by intervening areas of normal or emphysematous pulmonary tissue, obscuring, save in the hands of a skilled examiner, the evidences of pneumonic involvement. I have observed in croupous pneumonia profound toxic disturbances strongly suggestive of meningeal tuberculosis in little patients, when the physical signs were at first entirely absent, but appeared after several days in a small, sharply localized area. Too much stress cannot be laid upon the precaution, in doubtful cases, to examine every portion of the chest at short intervals.

Influenza in infants is very rarely attended with such systemic disturbance as to render possible its confusion with meningeal tuberculosis, yet cases may exhibit sufficient toxemia to afford uneasiness as to the actual condition. A year ago I saw in consultation an infant presenting such a group of symptoms as to justify a reasonable suspicion concerning the existence of meningeal tuberculosis, especially in view of a negative pulmonary examination and a persistence of profound stupor for nearly a week. A provisional diagnosis of meningeal tuberculosis had previously been rendered. Lumbar puncture not having been performed, I was impelled to recognize the possibility of an unusually severe influenza infection, which was then prevalent in epidemic form. This diagnosis subsequently proved to be correct.

Acute intestinal toxemia in children may simulate closely meningeal tuberculosis. The onset is sudden, and there is often present intense pain in the head. The temperature is invariably elevated and the patient is profoundly prostrated. As a rule, there is exhibited considerable stupor and the general clinical manifestations of a severe infection. For several days the possibility of acute tuberculous meningitis in such cases can be excluded only by close clinical observation.

Middle-ear disease, whether or not tuberculous, sometimes presents a group of symptoms rendering the condition impossible of differentiation from meningeal tuberculosis, save upon careful otologic examination. Suppuration of the middle ear may even produce optic neuritis. Nothing can be more embarrassing to the medical attendant after an anxious period of observation than to pronounce a diagnosis of meningeal tuberculosis, and subsequently note an immediate remission of the symptoms upon rupture of the membrane and evacuation of the pus.

Without the means of securing precise diagnostic data through recourse to lumbar puncture, experience has shown, as stated, either that cases of meningeal tuberculosis actually recover, or that the disease is simulated so closely by other conditions as to preclude accurate differentiation. I have in mind two interesting and illustrative cases from my experience. The first was observed about twelve years ago. The patient was an infant in arms, the mother being extremely delicate and the father a victim of pulmonary tuberculosis of several years' standing. The child displayed typical symptoms of meningeal tuberculosis, there being much wasting of the tissues, pronounced pallor with repugnance to food, great irritability and peevishness, and the characteristic hydrocephalic cry. There were retraction of the head, stiffness of the neck, and other symptoms of such a nature as to suggest almost beyond question the probability of meningeal tuberculosis. A provisional diagnosis to this effect was made by Dr. H. T. Pershing and myself, but an absolutely unfavorable prognosis was not rendered for reasons previously

outlined. The child made an eventual recovery, though developing shortly afterward caries of the upper dorsal vertebræ.

The other case was observed in July, 1906, the patient being a boy of four years, whose mother was exceptionally frail and the father tuberculous for several years. The illness occurred at a time when the family was sojourning for the summer in the mountains of Colorado, far removed from easy communication. The child had been delicate for months, poorly nourished, and exceptionally pale. Sleep and digestion had been disturbed, and the appetite capricious. After a prodromal period of peevishness and irritability the child developed fever, with vomiting and exceptionally severe headache. Physical examination was entirely negative, even to absence of splenic enlargement. The Widal test, several times employed, was invariably negative, as was also the search for the malarial plasmodium. The early restlessness was succeeded by beginning drowsiness and stupor. The temperature remained persistently elevated, constipation was marked, and the abdomen was carinated to a pronounced degree. The headache continued until stupor was well established. The loss of weight was very rapid, and the child speedily presented a much emaciated appearance. Mild delirium was present, with retraction of the head and marked stiffening of the neck. Kernig's and Babinski's signs were present, together with inequality of the pupils and conjugate deviation. Lumbar puncture was not employed, as this was considered hardly necessary for the establishment of a diagnosis which seemed almost incontrovertible. A month of the utmost anxiety was passed in efforts to support the child with concentrated liquid nourishment. Upon the gradual subsidence of the fever the patient was greatly prostrated for many weeks. He was unable to sit up in bed, and stiffness of the neck and retraction of the head persisted for several weeks. The subsequent convalescence was slow, but progressive. Kernig's and Babinski's signs disappeared completely, and the child was finally able to walk, although this was accomplished at first with the utmost difficulty, the locomotion being distinctly ataxic. There was inability to coördinate the movements of the lower limbs, and a perceptible dragging of the toes. This gradually improved following the employment of massage, strychnin, and potassium iodid, although to what extent these measures were of practical benefit it is impossible to state. If this was not a case of meningeal tuberculosis, it was, to say the least, a condition which I was unable to diagnose. The lesson to be learned from such an experience is to the effect that no matter how apparently hopeless the condition and how definite the diagnosis, the physician, in deference to his responsible trust, should refrain from assuming the hopelessness of despair, but should hold in reserve to the very end an abiding faith in the *possibility* of recovery.

The **treatment** of all cases of miliary tuberculosis, whether of the pulmonary, typhoidal, or meningeal variety, and entirely regardless of age, must be almost entirely symptomatic in character. Authentic reports are recorded of highly gratifying results following repeated lumbar puncture in tuberculous meningitis. Prompt benefit undoubtedly may occasionally be obtained upon removal of the cerebrospinal fluid, which, according to some observers, should be allowed to escape until the flow ceases spontaneously. Several cases of complete recovery have been reported despite the demonstrated presence of bacilli in the withdrawn fluid. This would appear to be possible, particularly when

bacilli of attenuated virulence are found. Piebold has reported a case of tuberculous meningitis in a girl of sixteen years, with a favorable termination, after two months' illness. Lumbar puncture was performed daily during the first two weeks, and twenty-four times altogether. A total of 574 c.c. of cerebrospinal fluid containing tubercle bacilli was removed. While I have not made personal use of lumbar puncture for other than diagnostic purposes, some evidence of its therapeutic utility in occasional instances has been reported.

SECTION II

TUBERCULOSIS OF THE PLEURA

INTRODUCTION

THE various forms of miliary tuberculosis have been described as resulting from the direct distribution of bacilli through the medium of the blood-stream, but infection of remote parts of the body may be of distinct hematogenous origin *without* accompanying evidence of acute miliary tuberculosis. Thus tuberculosis of the pleura, the peritoneum, larynx, and portions of the alimentary and genito-urinary tracts may occur as a result of conveyance of the infection by means of the circulation. This does not imply, however, that localized tuberculous processes may not exist in such organs and tissues by reason of some other method of bacillary invasion. Tuberculosis of certain organs may take place in some instances by reason of hematogenous invasion, but bacilli may be conveyed to the same portion of the body by means of the lymphatics, by direct contact with infected secretions, and, finally, by extension of the tuberculous process from immediately contiguous tissue. Tuberculous processes in remote portions, occurring *in connection* with acute *general* miliary tuberculosis, are of but trifling clinical importance, as the patient usually dies long before extensive changes are permitted to take place.

In view of the foregoing considerations it scarcely seems practicable to attempt the classification of the various disseminated tuberculous processes solely according to the precise method of bacillary transmission. The complicating tuberculous conditions in different regions, irrespective of their mode of invasion, will be considered, therefore, somewhat in the order of their relative importance and frequency.

Tuberculosis of the serous membranes is of essential interest, embracing the involvement of the pleura, pericardium, and peritoneum. Of these, the first named is the most important on account of its frequency and modifying effect upon prognosis.

CHAPTER XLIX

ETIOLOGY AND PATHOLOGY OF TUBERCULOUS PLEURISIES

In dealing with the pleural complications of pulmonary tuberculosis, it is well to discriminate between tuberculous infections of the serous membrane and the various intrapleural conditions due to other causes, yet coëxisting with the pulmonary infection and exercising a powerful influence upon prognosis. The distinguishing features between tuberculous and non-tuberculous involvements of the pleura accompanying pulmonary tuberculosis are often of bacteriologic and pathologic interest, rather than of especial clinical importance. At times it is exceedingly difficult to differentiate between them even by animal experimentation. It may afford greater clearness to consider, first, the etiologic relations of tuberculous pleurisies and, secondly, the essential clinical features of intrapleural complications in general.

Tuberculosis of the pleura is almost always secondary to infection in some other portion of the body, although it is often impossible to discover the primary source. Failure to do this offers no valid argument in favor of primary infection. The tubercle deposit may be the result of direct extension from the lung, or the infection may be conveyed from a bronchial gland by means of the lymphatics. In some instances it is known to exist as a type of miliary invasion without pulmonary infection. This form is often quite benign in character, and has been found to be more common than was formerly believed to be the case. The more frequent method of pleural invasion consists of direct pulmonary extension, the focus from which emanates the pleural infection being superficially located in close proximity to the serous covering. In such cases certain pathologic changes are prone to take place in the pleura prior to the deposit of tubercle. The initial hyperemia of the serous membrane, with accompanying superficial roughness incident to fibrinous transudation, may be sufficiently inflammatory in nature to produce small points of adhesion between the opposing surfaces. When the microörganisms, however, gain early and rapid entrance into the pleural cavity, the resulting inflammation is much more extensive, and localized adhesions, as a rule, do not take place.

Trauma of the chest, as in other parts of the body, is often the starting-point of a tuberculous infection. Its influence relates to a diminished power of resistance of the tissue-cells against the bacillus. Prior to a slight injury the presence of bacilli may result in an increased phagocytosis which retards bacillary growth and development. This defensive action is rendered much less effective by the inflammatory condition resulting from a slight traumatism.

While the infection is often conveyed to the pleura from enlarged bronchial or mediastinal glands, it has not been demonstrated that pleurisies are more prone to develop in individuals exhibiting the so-called scrofulous diathesis. Tuberculous pleurisies may follow tuberculous bone affections, as caries of the vertebra, ribs, or sternum. In the same way the pleura may be invaded by the progress of bacilli along the lymph-channels from the peritoneum in cases of peritoneal infection.

Medical opinion concerning the frequency of tuberculous involvement of the pleura has changed much in recent years. It may be assumed that pleurisies are oftener of tuberculous origin than was previously supposed. Twenty years ago the teaching in medical schools was to the effect that an exceedingly large proportion of so-called idiopathic pleurisies were presumably of tuberculous character. The clinical evidences, since presented, have tended to confirm what was regarded at that time as a reasonable assumption. Extreme views are entertained by some observers, who maintain that practically all serous effusions which develop without explainable cause are tuberculous in nature. This position is vigorously combated by clinicians, who point to the large number of recoveries without subsequent infection in other parts of the body. There are many reasons why it is difficult to arrive at strictly accurate conclusions concerning the frequency of tuberculous pleurisies. Even modern methods of diagnosis are subject to necessary limitations and are often inconclusive. In the past it has been customary to attach essential importance to such clinical data as a negative family history, an external appearance of health and vigor, the non-recognition of pulmonary phthisis or of tuberculous involvement elsewhere, and the failure to discover tubercle bacilli in the aspirated pleural exudate. In the problem of diagnosis but comparatively slight significance may be attached to any or all of these negative factors. Pleural effusions of undoubted tuberculous origin are observed with frequency in individuals presenting other manifestations of perfect health. It is idle in most cases to question the etiology of pleurisies complicating pulmonary tuberculosis, as a reasonable *prima facie* assumption is afforded as to their nature. At other times especial interest attaches to the bacteriologic findings. Failure to discover tubercle bacilli in the exudate withdrawn from the pleural cavity is the rule rather than the exception. The very fact of its sterility may be construed as being strongly suggestive of its tuberculous character, for the absence of other pathogenic microörganisms affords presumptive evidence that the cause of irritation proceeds from tubercle deposit. It must not be assumed, however, that the recognition of other bacteria in the exudate precludes in all cases the presence of tubercle bacilli. Pyogenic microörganisms may find their way into the pleural cavity from pulmonary excavations or mediastinal glands, or they may be introduced from without in the performance of aspiration. In this event the character of the effusion is completely transformed as regards its gross appearance, the pathologic findings, and the prognostic import.

The frequent inability to discover bacilli in the exudate by microscopic examination is susceptible of several different explanations. The initial tubercle deposit upon the pleural membrane is often sufficient to produce an exudation of serous fluid, long before its degeneration and softening permit an evacuation of bacilli. Apropos of their presence in comparatively small numbers in the exudate, it has been pointed out that a fluid medium inhibits to a certain extent their growth and development. Cornet has suggested that the bacilli sink to the bottom of the pleural cavity and, therefore, are rarely withdrawn upon aspiration. I am not sure that the accuracy of this statement is subject to demonstrable proof. Even were they prone to gravitate to the more dependent portions, it would appear that their exit should be facilitated upon aspiration by the rise of the diaphragm and the increased expan-

sion of the lung. Attention is called to the comparative thoroughness of aspiration in early cases, quite irrespective of the point of needle insertion. Unless a considerable amount of liquid is permitted to remain, the cavity becomes obliterated to a great extent. In the event that paracentesis is employed by means of trocar and cannula, the egress of bacilli is further enhanced by the succussion resulting from the respiratory excursions and their projective effect.

It is probable that in many instances inability to detect bacilli in the exudate has been due to faulty technic in the preparation of the specimen. I am impelled in part to this belief by the fact that among my own patients bacilli have been discovered with comparative frequency in pleural exudates which have been submitted to skilled pathologists for examination. In doubtful cases the diagnosis may often be established by animal inoculation. A tuberculin reaction has been obtained by Débove and Renault by injecting into tuberculous patients a portion of the filtrate of the exudate. A recent means of clinical diagnosis to which the term "cytology" is applied, relates to a study of the cellular elements after centrifuging and staining. An essential characteristic of tuberculous effusion is the great frequency of lymphocytes, which constitute the larger portion of the cells.

A still more recent method has been described by Jousset. His process consists of the use of a digestant composed of pepsin, one-half gram; glycerin and hydrochloric acid, of each, 10 c.c.; sodium fluorid, 3 c.c.; distilled water, 1000 c.c. The sediment is inoculated into animals after centrifuging. "He claims by this method to find tubercle bacilli in almost all cases of serous pleuritic exudate, and in that from many cases of peritonitis'' (Behring and James).

Osler calls attention to the fact that, in order to make the test fairly reliable, a comparatively large amount of the fluid exudate must be inoculated. He alludes to Eich's result in inoculation experiments, who reported 62 per cent. as tuberculous upon the use of 15 c.c. of the exudate, while 0.1 per cent. of his cases were positive from the inoculation of 1 c.c. Several of the French observers have reported nearly all their primary pleurisies to be demonstrably tuberculous in character by means of the inoculation test.

The difficulties attending a precise conception concerning the frequency of tuberculous pleurisies are occasioned not only by neglect to secure a definite clinical diagnosis, but as well by inability to interpret accurately the subsequent histories of affected individuals. Many patients are lost sight of entirely, while others, though subject to observation for a period of years, do not afford in themselves sufficient authentic data to justify important conclusions. In a series of cases of uncomplicated serous effusion Cabot reports 80 per cent. to be in good health after five years or more, half of this number having been followed for a period of ten years. Ninety per cent. were reported in apparent health at the expiration of two years or over. Fifteen per cent. of the entire number eventually developed tuberculous processes in other parts of the body. Three per cent. exhibited manifestations of tuberculosis within two years following the effusion. He cites, however, two patients who developed a very rapid form of tuberculosis even after the expiration of nine and sixteen years respectively. No report was made as to what percentage of the entire group was demonstrated to be of tuberculous origin. It is apparent that the clinical evidence adduced from

reference to the subsequent histories of these cases is to the effect that, in the vast majority of instances, there was but little relation between the pleural effusion and the subsequent exhibition of tuberculous manifestations in other parts of the body. This series of cases may be regarded as forming the basis for a reasonable belief in the apparent curability of many tuberculous pleurisies, and in the infrequent clinical evidence of extension to other regions. For a long time genuine tuberculous pleurisies have been looked upon as subject to complete recovery in many cases. The type of pulmonary tuberculosis characterized by initial pleural involvement is generally conceded to be one of the most benign forms of the disease. Incipient tuberculous processes involving the pleura are peculiarly prone to undergo entire arrest, and it must not be assumed, therefore, that a negative history of pulmonary infection, even after a prolonged interval following an idiopathic effusion, is to be construed as a valid argument against a possible tuberculous exudate. Further, after the lapse of several years, a rigid physical examination, though negative in result, can scarcely preclude entirely the tuberculous nature of the initial pleural affection.

It is interesting to note that Kelsch and Vaillard have reported the autopsy findings of sixteen cases of idiopathic pleurisy in which a complete cure was believed to have been secured, yet the tuberculous nature of the involvement was demonstrated beyond question. It is easy to conceive of dormant and quiescent tuberculous infections entirely incapable of clinical recognition for an indefinite number of years, yet under suitable conditions, susceptible of being eventually aroused to renewed activity.

While idiopathic pleurisies, as a rule, are characterized by an apparent mildness of the original infection, it is none the less true that in some instances a progressive pulmonary tuberculosis may subsequently develop. Several times after an apparently benign serous effusion I have noted the early onset of pulmonary symptoms with a rapid decline to a fatal issue. Out of a total of 2070 cases of pulmonary tuberculosis observed in private practice, 67 present the history of an *antecedent* serous pleural effusion. In 42 the pulmonary symptoms developed after the lapse of two years or over following the pleurisy; 8, from one and one-half to two years; 4, from one to one and one-half years; 9, from six months to a year, and 4 slightly under six months. One hundred and twenty-six others referred the onset of the pulmonary infection to an *accompanying* pleurisy. It is safe to assume that an exceedingly large proportion of idiopathic serous effusions are actually tuberculous in character. While a prolonged period of apparent health in many cases indicates a pronounced tendency toward spontaneous arrest, it cannot be regarded as casting a shadow upon the probable tuberculous origin.

The **pathologic changes** incident to tuberculous pleurisy relate to tubercle formation, inflammatory changes, with or without effusion, and fibrous tissue formation. But brief allusion need be made to essential anatomic conditions.

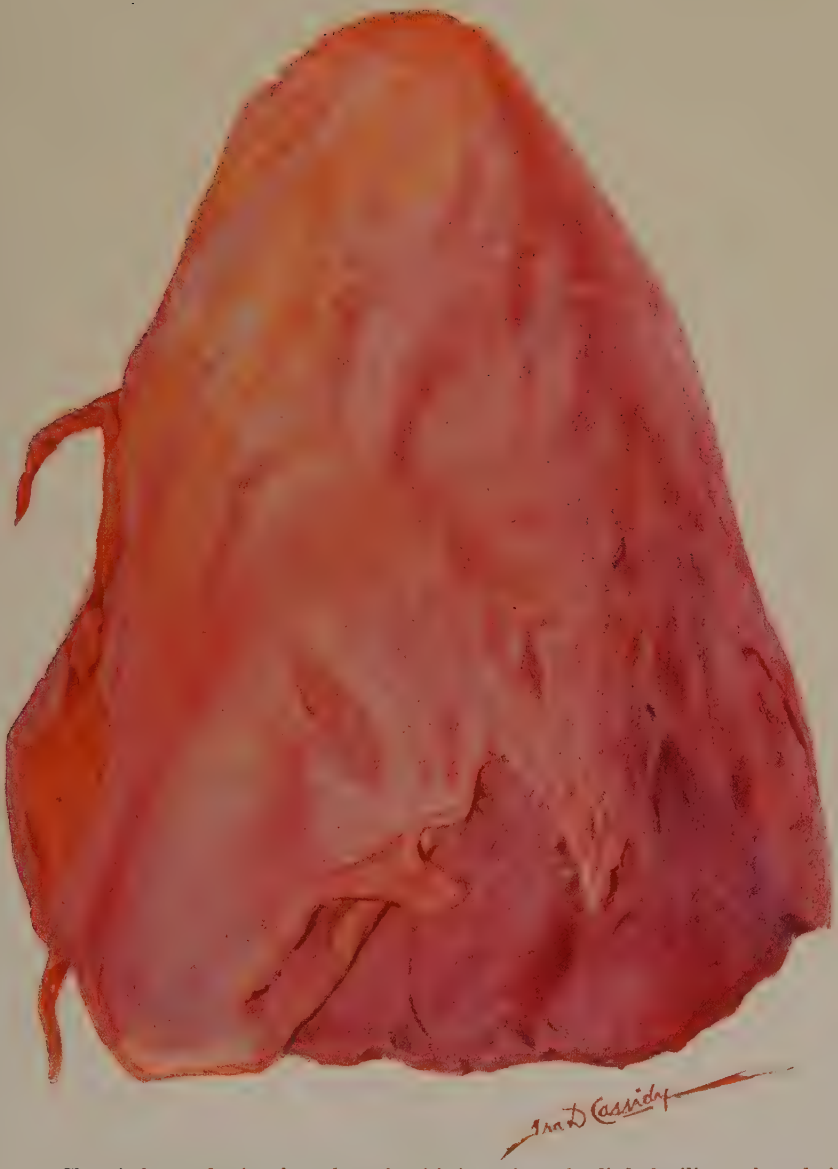
In dry pleurisies the serous membrane is covered by a layer of fibrinous exudation, to which there is imparted either a granular or a rough, shaggy appearance. In mild cases the inflammatory lymph undergoes resolution, and following its liquefaction is reabsorbed to a considerable extent. In other cases adhesions take place, producing a union of the

opposing membranes. The agglutination of the pleural surfaces may be confined to one or several small areas which correspond to the fibrinous deposits. In the event of extensive and advanced pleural involvement, and especially following the disappearance of an effusion, the adhesions are apt to be more complete and permanent. The membranes may become glued together over wide areas, or there may be extensive connective-tissue formation, resulting in the production of numerous fibrous bands. These adhesions are extremely tough and unyielding, and the pleura moderately thickened. Small tuberculous nodules are scattered over the surface of the membrane and throughout the new-formed tissue, in which cheesy foci are often embedded. Large caseous masses, however, are rarely present, the tubercle deposits, as a rule, being small in size. General inflammation is not always noticed, particularly if the infection is the result of miliary distribution. In some instances there is an eruption of gray tubercles, unattended by other than a slight local inflammatory change. If more or less diffused inflammation is found accompanying an eruption of miliary tubercles, it is likely that the infection of the membrane has resulted from a tuberculous focus closely contiguous to the pleura itself, as caries of the vertebra, an infected lymphatic gland, or a tuberculous lung.

The inflammatory change is often sufficient to produce an effusion of liquid into the pleural cavity. When this exudative process is the result of pure tuberculous infection, unaccompanied by pyogenic microorganisms, the fluid consists of a straw-colored, transparent, serous accumulation. It is very albuminous, and sometimes capable of spontaneous coagulation, dense, flocculent masses being suspended in the exudate. These masses sink to the dependent portion of the pleural cavity, where they are retained as thick, whitish accumulations. The exudate contains leukocytes and red blood-cells, fibrin shreds, and cells from the endothelium of the pleura. The leukocytes are sometimes sufficiently numerous to impart a distinct turbidity to the fluid. The red blood-cells in turn may be present in such numbers as to transform serous into hemorrhagic effusions. The exudate may be slightly discolored or contain almost pure blood. Two years ago I withdrew by aspiration from the pleural cavity of a tuberculous invalid eighteen ounces of blood, which immediately coagulated. I have had a similar experience in three phthisical patients in whom the tuberculous pleurisy was complicated by the presence of other microörganisms, notably the pneumococcus.

The quantity of fluid within the pleural cavity may vary from one-half pint to several quarts. The effusion is sometimes purulent in character, though seldom when solely of tuberculous origin. The transition of a serous effusion into a purulent one is sometimes occasioned by the introduction of pathogenic microörganisms as the result of an unclean exploratory or aspirating needle. In cases of mixed infection the specific infective agents, chiefly the streptococci, staphylococci, and pneumococci, are readily found in the exudate. Pleurisies which are distinctly purulent from the beginning rarely contain tubercle bacilli, but are incident to such infectious diseases as scarlet fever, typhoid fever, and pneumonia. Purulent effusions are peculiarly apt to occur in children, and at this age serous exudates are less frequent than in adults. Among the latter the existence of empyema is provisional evidence that the tubercle bacillus, though possibly the initial exciting cause, is not the sole etiologic factor. I

PLATE 10.



Chronic hyperplastic tuberculous pleuritis in patient who died of miliary tuberculosis. Note the enormous thickening and congestion of entire pleural surface. This lung (left) was taken from the same patient as was the lung in Plate 3.

am convinced, from my own experience, however, that pure tuberculous exudates present varying degrees of cloudy opacity more frequently than has been supposed. My attention was early attracted to the disturbing frequency with which initial serous fluids were gradually converted into semipurulent effusions following a number of aspirations. The primary assumption was entertained that, despite rigid aseptic precautions, an infection had been conveyed to the pleural cavity simultaneously with the introduction of the needle. Inasmuch, however, as an absolutely irreproachable needle was used, the inference was reasonable that all possibility of infection was obviated. Confirmation of this belief has occasionally been found in the sterile nature of the exudate in successive aspirations, notwithstanding its greater opacity and increasing number of leukocytes. I have observed a few such instances of cloudy, though scarcely purulent, effusion in tuberculous individuals at the time of the first aspiration.

While purulent effusions are sometimes entirely sterile, suggesting the possibility of a tuberculous origin, the pyogenic microörganisms are discovered in a large proportion of cases. These effusions separate on standing into an upper layer of yellowish-green serum, with heavy creamy pus at the base. The so-called tuberculous empyemas are rarely, if ever, fetid,the pus usually being thick and homogeneous.

CHAPTER L

SYMPTOMATOLOGY OF TUBERCULOUS PLEURISY

The general *symptomatology* of tuberculous pleurisy does not differ essentially from that of the non-tuberculous variety. Inasmuch as the clinical features are practically identical, it is not designed to discuss the symptoms of tuberculous pleurisy as a separate disease, but to consider chiefly its relation to pulmonary phthisis. Attention is called especially to the frequency of intrapleural complications in consumption, and to their practical influence in determining final results. The clinical manifestations referable to the various pleural conditions are frequently of greater importance than those dependent upon the pulmonary involvement.

The early symptoms of pleurisy among consumptives may be fairly acute or of trifling character. In some cases the onset is very insidious, and entirely devoid of clinical manifestations. In acute cases the principal symptom is pain in the side, which is usually sharp or stabbing in character, and intensified upon deep respiration or cough. An extreme variability is exhibited in the degree of pain experienced by different individuals. In some instances it is so slight as to occasion but little complaint; in other cases it is very distressing. I have observed many invalids whose suffering was most excruciating and was relieved only by large hypodermic doses of morphin. I recall one instance of initial pleural pain in a delicate woman whose anguish was so extreme as to demand over a grain of morphin in the course of a few hours, after hot applications, fixation of the ribs with tight adhesive

strapping, and dry cupping had not proved of the slightest avail. Seldom have I found the pain referred to the nipple, but in the majority of cases to the inferior axillary region. It is often reported to be most severe near the lower margin of the ribs, and it is occasionally felt in the abdomen and back, in this event suggesting the possibility of a diaphragmatic involvement. In such cases the pain is enhanced by pressure over the insertion of the diaphragm in the region of the ninth and tenth ribs. Fever, if present at all, is usually moderate. It may be of but a few days' duration, or in individual cases persist for many weeks. In acute pleurisy cough is usually a symptom of minor importance. Expectoration is scanty, and consists largely of viscid mucus which now and then is streaked with blood. Dyspnea may be a conspicuous feature of cases having an acute onset. The stabbing pain in the side often imparts a characteristic restrained and interrupted type of respiration. While these initial manifestations of acute pleurisy are extremely suggestive of the condition, they are occasionally simulated by the early symptoms of pneumonia, while effusions of large size may exist without the slightest subjective disturbance. I have found with great frequency small and moderate effusions among pulmonary invalids in the absence of all rational symptoms. Recognition of the condition has been afforded in the course of routine physical examinations, and no suggestion conveyed by fever, dyspnea, pain, cough, nor by such prodromal symptoms as malaise, loss of appetite, or emaciation. Without detailed exploration of the chest all so-called latent pleurisies must escape detection. That pleurisy with effusion is much more frequent than is generally supposed is explained almost entirely by the fact that it is overlooked in many instances. Provided an effort is made to conduct a thorough chest examination, it is difficult to conceive how even a moderate effusion can remain unrecognized. When such is the case, this must be regarded as due to faulty and superficial methods of physical exploration.

Upon inspection there may be noted in some cases a diminished respiratory excursion upon the affected side, the degree of immobility varying in accordance with the amount of pleural exudation. Obliteration of the intercostal spaces sometimes takes place, and the entire side may present a round, bulging appearance. Palpation serves to confirm the results of inspection with reference to the unilateral restriction of respiratory movement, and in addition affords extremely valuable evidence by virtue of greatly diminished or absent vocal fremitus. This tactile fremitus is almost always found to be lessened, even over the site of small effusions. Recourse to mensuration is of but little avail in determining the presence of pleural effusions, as among consumptives a considerable disparity between the two sides of the chest is not infrequent. No convincing evidence is thus afforded as to the existence of a pleural effusion, the signs of which are usually subject to easy recognition by other means.

Percussion of the entire chest is of the utmost value in a search for small and moderate pleural effusions among phthisical patients, although the results are sometimes obscure on account of the extensive pathologic changes that have already taken place in the pulmonary tissues. Among consumptives this is particularly true upon percussing the back, on account of the enormous pleural thickening which is sometimes present at one base. Further difficulties are experienced by reason of the

varying degrees of pulmonary infiltration or areas of partial consolidation. Failure to exhibit typical percussion boundaries may be occasioned by the presence of a partially consolidated and non-compressible lung. The difficulty of correct percussion interpretations will at once be appreciated upon consideration of the modifications of resonance produced by such preëxisting pathologic change. It is not always easy by percussion alone to outline with precision the border-line between the flatness of a pleural effusion and the marked contiguous dulness incident to compressed lung. In some instances but a thin stratum of fluid is molded around the lung, serving as an intervening layer between it and the chest-wall. The so-called skodaic resonance so frequently recognized in the subclavicular region among non-consumptives and resulting from the relaxation of pulmonary tissue is not obtainable among phthisical patients, who exhibit in this region varying

Fig. 94.—Typical letter "S" curve, moderate pleural effusion.

degrees of consolidation or cavity formation. As a result of the numerous pleural adhesions and the dense fibrous bands traversing the pleural cavity and invading the lung, the former may be subdivided into several circumscribed chambers. In such event an effusion is prevented from assuming the characteristic curve so common among non-consumptives.

Generally speaking, there is either complete flatness, or extreme dulness upon percussion over the seat of the effusion. The resonance has often been described as of a peculiarly wooden or resistant quality. The typical letter "S" curve which marks the boundary between the lung and the effusion is not always subject to verification among pulmonary invalids, as has been stated, on account of previous morbid changes in the lung and pleura. When present, however, the lowest point of the curve is invariably near the spine, and extends upward and outward to the shoulder or upper axilla, as shown in Fig. 94. From this point the line of dulness descends obliquely in front in a perfectly straight line. This peculiar configuration of the upper per-

cussion boundary is present only if the effusion is of moderate size. As this increases the curved line of dulness presents an upward concavity, which is often extremely difficult of recognition. In slight pleural effusions the letter "S" curve is entirely absent the line of dulness proceeding from the spine and dropping suddenly in the axilla, as depicted in Fig. 95. It will be noted that, as the fluid increases from a small to a moderate size, there is an abrupt and pronounced change in the upper boundary of percussion dulness. This phenomenon, first recognized by Weil, and to which Whitney called attention in 1894, I have had occasion to confirm in innumerable instances. It is the small effusion that most frequently escapes detection, the area of flatness being confined to the lower posterior portion of the chest, sometimes extending laterally but a short distance. A

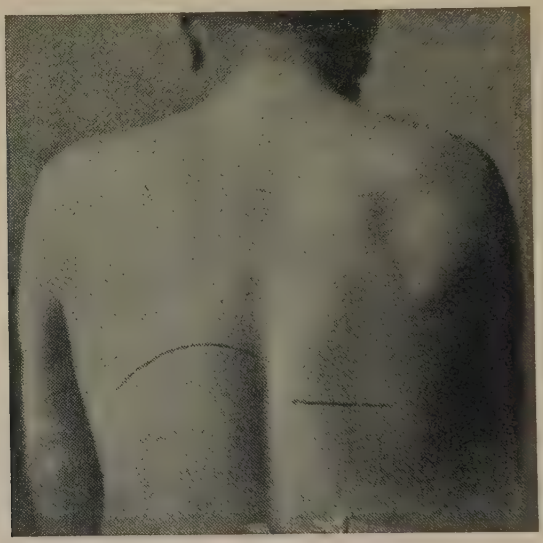


Fig. 95.—Outline of percussion dulness in small pleural effusion. Note lower border of right lung.

striking verification of the letter "S" curve in moderate effusions will be found by reference to the radiograph (Fig. 73).

Respiratory sounds and even moist râles are not uncommonly heard with distinctness through an area of dulness. Thus it is apparent how such an effusion may be overlooked even by careful and experienced examiners. It is exceedingly important to percuss to the very base of each lung in the back, and to outline the lower border of resonance in order to compare accurately the two sides. The difficulties in the way of correct conclusions in such comparison may be increased by a unilateral compensatory emphysema, which materially depresses the lower boundary of resonance.

The auscultatory signs of especial importance relate to the intensity of the respiratory sounds and of the vocal resonance. In early pleurisy adventitious sounds are often heard before deviations from the normal respiratory murmur. Allusion has been made to Jürgenson's sign, which consists of a peculiar soft rubbing sound simultaneous with the respiration. This may be present in the beginning of a distinct

tuberculous pleurisy, particularly if of the miliary type. In many cases dry friction-rubs are recognized in the axillary regions. The sounds may be fine and grazing in character, or loud and creaking. As a rule, they are intensified by pressure with the stethoscope. Occasionally the sounds are somewhat similar to the crepitant râle previously described. They sometimes reappear after the absorption of an effusion. Pleural friction-rubs are often jerky or interrupted, and are heard both with inspiration and with expiration.

In cases of pulmonary tuberculosis without consolidation of lung near the site of the pleural involvement, and without marked pleural thickening and adhesions, the normal respiratory sounds at first may not be appreciably altered. As the pleural exudation increases the breath-sounds become enfeebled and markedly distant, and in large effusions disappear altogether. Above the level of the liquid the sounds are sometimes bronchovesicular in character, with a distinct prolongation of the expiration. Confusion regarding the auscultatory signs may result from a coincident tuberculous infiltration in inferior portions of the lung. Under such conditions the respiratory sounds, though somewhat distant and often of diminished intensity, may partake more or less of the characteristics of bronchial or bronchovesicular respiration. Still greater confusion arises if small pleural effusions exist in connection with localized areas of bronchopneumonic consolidation. The signs in such cases are occasionally quite suggestive of pulmonary cavities, particularly if distinct bubbling râles are recognized. On the other hand, circumscribed areas of bronchopneumonia may partially simulate the signs of pulmonary cavities or even of a pleural effusion.

Recently I have seen in consultation a boy of seventeen, the son of tuberculous parents, who, in the midst of a severe attack of influenza, exhibited a small patch of bronchopneumonia at the right apex. This was followed in a few days by several distinct areas of consolidation at the base. During the early period of his illness he was seen in consultation by a physician of prominence, who diagnosed the circumscribed bronchopneumonic process at the apex as a tuberculous pulmonary cavity. Several days later another physician of exceptional ability recognized the pneumonic character of the affection at the apex on account of the increasing area of consolidation, but announced the existence of a pleural effusion. Upon examining the patient, after the lapse of several days, I was unable to recognize any evidence of pleural effusion, but found an unmistakable bronchopneumonia at the base. Resolution of the consolidated areas speedily followed. Such errors of diagnosis are perfectly natural and may easily fall to the lot of the most experienced examiner.

It is often difficult to distinguish perfectly from the breath-sounds alone, between effusions and extensive pleural thickenings and adhesions. In both instances there is dulness upon percussion, and the respiratory sounds may be greatly enfeebled or absent altogether. The vocal resonance and fremitus, which are diminished or absent in pleural effusions, sometimes are also less intense over the site of extensive pleural thickening. The employment of these signs, however, is of great value in the differentiation of pleural effusion and consolidated lung. Generally speaking, the vocal resonance and fremitus are accentuated over areas of consolidation or compression, and lessened to a pronounced degree over pleural exudates.

Egophony, which has been described under Physical Diagnosis, is sometimes heard above the level of the liquid. In tuberculous patients, however, with pulmonary infiltration at the bases, it may be recognized directly over an effusion. But little importance is attached to Baccelli's sign, which consists of the transmission of the whispered sound through serous but not through purulent exudates.

CHAPTER LI

DISPLACEMENT OF ORGANS

Displacement of organs may result from the pushing force of a pleural effusion and from the traction incident to excessive fibrous tissue formation. Among pulmonary invalids a cardiac displacement is of much less importance as an aid to the diagnosis of large pleural effusions, than among non-phthisical patients. If the pulmonary disease has been of long standing, a pronounced traction dislocation of the heart often exists prior to the development of an effusion. The characteristic changes in the position of the heart and in the location of the apex impulse are often lacking, therefore, among consumptives in spite of large effusions. It is not uncommon to find the heart permanently dislocated to the left by adhesions and fibrous tissue proliferation, notwithstanding a moderate left-sided exudate, and, for the same reason, displaced to the right in the presence of a corresponding pleural effusion.

In general, however, the pressure of liquid in the right pleural cavity often suffices to displace the liver downward and the heart somewhat to the left. In left-sided effusion the heart may be pushed to the right, although the relative position of the apex to base is not, as a rule, altered to any great extent. The contraction changes incident to the formation of new connective tissue are sufficient to pull the heart in almost any direction. The traction is usually the result of extensive fibrous tissue proliferation in the lung as well as in the pleura. Upward displacements from contraction of mediastinal pleura are far more common than is generally supposed. The most radical malpositions take place when the fibrous tissue proliferation proceeds from chronic pleurisies. The cardiac displacement is then accompanied by deficient unilateral expansion, more or less marked retraction of the side, diminished percussion resonance, and impaired respiratory sounds. The pleural surfaces are enormously thickened, and sometimes firmly united, while fibrinous bands may connect the pleura with the pulmonary tissue. Moderate traction displacements are very often observed in pulmonary invalids.

I have been impressed by the decided frequency with which the *x*-ray has shown changes in the position of the heart as the result of fibrosis, notwithstanding the non-recognition of the displacement upon physical examination. From the evidence afforded in my own cases it seems reasonable to suppose that a permanent dextrocardia or a sinistrocardia occurs in a very large number of cases of chronic

pulmonary tuberculosis. Contractile changes, like pleural effusions, may not only effect a dislocation of the *heart* as a *whole*, but may also produce occasionally an alteration in the relative position of the apex to base. In cases of traction displacement to the left, the apex is frequently more or less elevated, which is not the case in right-sided dislocations. Contractile processes in the upper portion of the left lung, with pronounced involvement of the mediastinal pleura, may be sufficient to lift the heart upward and slightly to the left. There may be, however, a disproportionate displacement of the apex, which is pulled upward toward the left axilla. It is much less common to note an elevation of the apex in right-sided displacements, as the line of traction is not exerted upon the apex itself. In such malpositions the heart is moved more or less *en masse*, although the visible and palpable impulse is sometimes recognized as far to the right as the nipple, or even beyond this point. This apparent apex impulse, however, may be in reality but a transmission of the

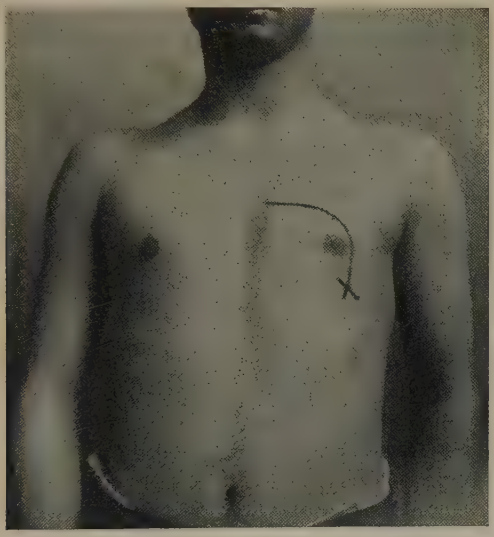


Fig. 96.—Slight cardiac displacement to the left in case of long-standing tuberculous involvement.

movements of the right ventricle, which has become pulled into direct contact with the chest-wall.

The extent of cardiac displacement frequently observed among pulmonary invalids as a result of fibrous tissue change is shown in Figs. 96 to 103. In each instance the photograph was taken after scrupulous care in outlining the area of cardiac dulness, the × indicating the point of maximum cardiac impulse.

Fig. 97 illustrates an extreme left-sided malposition in a young man of seventeen years, as a result of fibrosis incident to the arrest of an extensive tuberculous involvement. The condition of the patient upon arrival in Colorado, April, 1906, was regarded by several physicians including myself as extremely desperate. There was emaciation with marked physical debility, pronounced pallor, an afternoon temperature of 103° F. or over daily, frequent distressing cough, and dyspnea. The pulse was invariably rapid, rarely receding

under 120 in the morning. Examination of the chest disclosed extensive active infection of the entire left lung, which was consolidated to a moderate extent. Coarse bubbling râles were heard from apex to base. Moisture was also detected in the right lung from the apex to the clavicle and to the middle third of the interscapular space. At the expiration of eight months the patient had gained sixty pounds in weight, exhibiting an entire disappearance of fever, cough, and expectoration. During the past year further improvement has been continuously maintained. There are no longer physical signs in the right lung, and upon the left side there is a marked lessening of the activity of the process, with extensive fibrosis. There is no moisture in the left front, and but occasional fine clicks in the back. Skiagraphic confirmation of the percussion cardiac boundaries is shown in Fig. 63.

Fig. 98 illustrates the possibility of extreme lateral displacement attending a tuberculous pleurisy with pulmonary infection. The patient, twenty-nine years old, came to Colorado January 6, 1900, eight

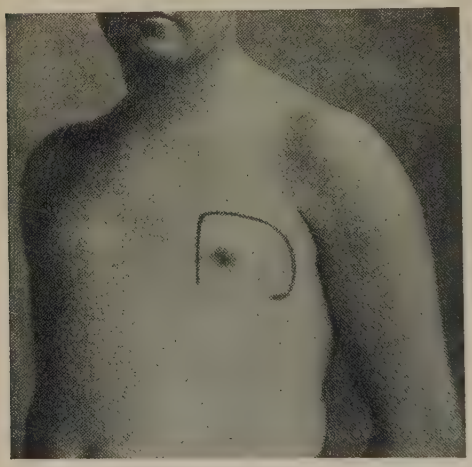


Fig. 97.—Dislocation of the heart from contractile processes in pulmonary tuberculosis. (Compare with radiograph, Fig. 63.)

Fig. 98.—Extreme lateral displacement of heart as a result of chronic pleurisy complicating long-standing pulmonary tuberculosis. (Compare with radiograph, Fig. 66.)

years after the development of a tuberculous invasion. There were great loss of weight, physical debility, and dyspnea. In addition to tuberculous involvement of each lung a left-sided pleural effusion was recognized. Upon aspiration there were withdrawn eight ounces of dark blood, which immediately coagulated. Several subsequent aspirations were of similar character. Extensive connective-tissue change emanating from the pleura and involving the lung has resulted in the displacement shown by physical examination and confirmed by the skiagraph as shown in Fig. 66. The patient has completely recovered from the tuberculous process. Unilateral retraction of the chest is very apparent.

The next case presents features in striking contrast to the preceding. A young man twenty-six years old, a patient of Dr. Hooker, of Springfield, Mass., came under my observation February 11, 1899. His illness developed in November, 1898, at which time he experienced a series of very severe hemorrhages. There was moderate tuberculous

infection of the right lung. Shortly after arrival, however, a pleural effusion developed upon the right side, which was aspirated several times, and a large quantity of serous fluid withdrawn. The patient made an uninterrupted recovery and has enjoyed a period of active usefulness.

While there are no physical or subjective evidences of a remaining active infection, a marked unilateral deformity has taken place, as

Fig. 99.—Well-marked unilateral deformity resulting from contractile changes in the lung and pleura.

shown in Fig. 99. It is interesting to note, however, that despite the extensive contraction change the position of the heart remains practically normal, as shown in Fig. 100. Another noteworthy feature

Fig. 100.—Photograph of same patient as Fig. 99. Note the inclination of the lower part of the sternum toward the affected side without traction displacement of the heart.

is the swinging of the sternum toward the affected side, as indicated by the straight line drawn directly over the center of the sternum.

Fig. 101 represents the position of the heart as determined by percussion in a woman of twenty-five suffering from extensive tuberculous infection of both lungs of ten years' duration. At the time she came under my care, December 12, 1898, the condition was extremely

unfavorable. There were daily temperature elevations, malnutrition, and active tuberculous involvement throughout the right lung, with slight infection of the left. An apparent arrest of the tuberculous process in the right lung was eventually secured, the fibroid changes becoming

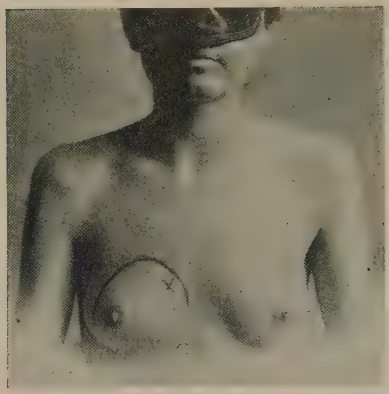


Fig. 101.—Right-sided displacement of the heart as a result of the contraction changes in the right lung incident to long-standing pulmonary tuberculosis. (Compare with radiograph, Fig. 62.)

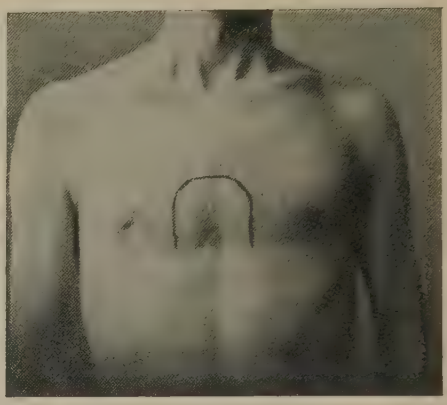


Fig. 102.—Displacement of the heart in a patient with extensive tuberculous involvement of right lung. (Compare with radiograph, Fig. 56.)

extremely marked. Subsequently there resulted a renewed activity of the infection. The extent of the displacement as determined upon percussion is verified by the *x*-ray picture (Fig. 62). The skiagraph not only illustrates the marked traction exerted upon the heart by the

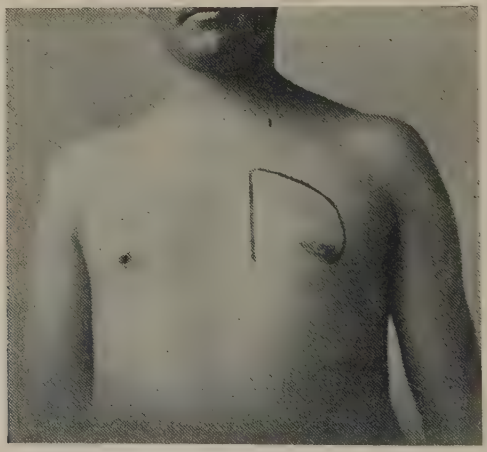


Fig. 103.—Illustrating slight cardiac displacement to the left and upward in a patient with pulmonary tuberculosis of many years' duration.

fibroid proliferation, but also the extensive pathologic change throughout the entire chest.

In cases similar to those just cited, it is manifest that no significance can be attached to the cardiac displacements as an aid to diagnosis of pleural effusions.

CHAPTER LII

DIAGNOSIS AND PROGNOSIS OF PLEURAL EFFUSION IN PULMONARY INVALIDS

Great variations are observed in the course of pleurisies developing among pulmonary invalids. The fever which is often present in the beginning may not continue longer than a week or ten days, but in some cases the temperature may remain elevated for prolonged periods, and be associated with other symptoms of constitutional disturbance, more or less profound, according to the bacterial nature of the effusion. As a rule, the manifestations of cardiac and respiratory embarrassment correspond approximately to the size of the exudate. It is surprising, however, to note occasionally considerable dyspnea with temperature elevation and a rapid pulse in comparatively small effusions. Comment has been made upon the fact that astonishingly large pleural exudates may exist without the slightest symptoms of their presence. The effusion may remain of small or moderate size for a short period and disappear, or it may persist indefinitely without perceptible increase in volume.

While the effusion in many cases is absorbed with varying degrees of rapidity it sometimes is found to increase progressively in size, the volume of contained liquid being so great as to demand removal. In such cases, particularly among pulmonary invalids, there is considerable likelihood of reaccumulation, even if the effusion be serous in character. I have never seen sudden death from pulmonary embolism in connection with pleural effusions, although instances of this have been reported, especially when the heart has been greatly dislocated. In one instance, however, a sudden fatal termination took place twelve hours after the withdrawal of a large effusion.

From what has been stated with reference to the physical signs, it is conceivable that errors of *diagnosis* should occur, only in exceptional cases, provided there be conducted an intelligent chest examination. Non-recognition of pleuritic complications is occasioned in the majority of instances, not because of any absence of readily available data for this purpose, but through failure to apply the established principles of diagnosis to the evidence presented. In this connection it may be stated that the frequent unfortunate results of treatment are sometimes due not so much to the lack of adequate therapeutic measures, as to the misconception of their rational scope in individual instances. It may be stated parenthetically that, unlike many diseases of the lungs, the primary obstacles to success in the management of pleural complications in pulmonary tuberculosis may not be ascribed invariably to delayed diagnosis. It is a humiliating reproach to state that not infrequently the interests of the patient would be better subserved if the condition remained unrecognized. The justice of this reflection upon the medical and surgical management, in some cases, will be later explained. While early diagnosis must be encouraged through detailed examinations of the chest, the essential considerations relate to a correct interpretation of the prognostic significance of the effusion in individual cases, and an intelligent appreciation of the rationale of remedial measures. Let

it be emphasized that the existence of pulmonary tuberculosis very materially modifies the consideration of those surgical methods which may be styled operations of *expediency*. At the same time the consumptive, no matter how hopeless his condition, is entitled, by virtue of every instinct of humanity to the fullest measure of surgical aid in conditions involving so-called operations of *necessity*. My conclusions are derived from the errors as well as the successes incident to personal experience. More of real benefit sometimes accrues from an opportunity to witness the deplorable results of mistaken judgment than from the elated observation of a successful issue following a fortunate choice of procedure.

In support of views to be presented, a few illustrative cases will be presently introduced.

The diagnosis of pleural effusion is too frequently dependent upon an employment of the aspirating needle. A provisional diagnosis having been established by the physical signs, verification is commonly attempted through recourse to exploratory puncture. This procedure, though often affording positive results, does not invariably yield information of a reliable nature, owing to errors of technic in inexperienced hands. I have known numerous instances of moderate effusion, particularly of circumscribed empyema, to remain unconfirmed by aspiration.

The tendency to withdraw the pleural exudate is especially strong among young practitioners. So far as the *diagnosis per se* is concerned, the use of the aspirating needle by trained clinicians affords a most trustworthy and reliable aid to accuracy of conclusions. In the majority of cases, however, a rigid and painstaking examination of the entire chest is sufficient to enable a skilful clinician to arrive at an accurate diagnosis. Attention has been called, however, to the peculiar difficulties sometimes involved in the physical examination of pulmonary invalids with complicating pleural effusions. For years it has been customary for writers to emphasize the variation in the level of percussion dulness in pleural effusions upon change in the position of the patient. While I am not prepared to deny with positiveness that some slight modification of the level of the effusion may be detected in exceptional cases when the patient assumes a different position, my own experience is to the effect that such mobility of percussion outlines, as a rule, is exceedingly slight, and rarely constitutes a factor of especial diagnostic value. It appears unwise to lay stress upon a technical point which is often incapable of detection even by expert examiners, for confusion and discouragement must unavoidably result in the minds of students who attempt to recognize the existence of so slight and inconstant a variation of percussion boundaries. As a matter of fact, the only practical value attaching to change in the level of the effusion simultaneously with differing postures, is found in cases of pneumopyothorax, in which there is not only liquid, but air, in the pleural cavity. In these cases the change is most pronounced and should be capable of recognition by the veriest amateur in physical examinations. There are other interesting features in connection with the level of the liquid in the latter affection, which will be discussed in their appropriate place.

The subjective symptoms in pleural effusions, though decidedly unreliable as diagnostic features, are nevertheless possessed in some instances of more or less clinical importance. The gradual development, the moderate fever, slight cough, and scanty, mucoid expecto-

ration are distinctly suggestive of pleural effusion in contradistinction to the sudden onset, the chill, abrupt elevation of temperature, distressing cough, and tenacious or blood-streaked expectoration characteristic of pneumonia. The dyspnea is almost always accentuated to a greater degree in pneumonia than in pleural effusion. I have been in the habit of attaching considerable diagnostic significance to the presence of herpes labialis in pneumonia. Although by no means pathognomonic of this condition, it is, at least, quite unusual in acute pleurisies. The existence of leukocytosis in doubtful cases is, of course, suggestive of pneumonia.

The *prognosis* of pleural effusions in consumptives depends primarily upon the extent and degree of activity of the tuberculous process, and conforms to a great extent to the principles of prognosis enumerated with reference to the pulmonary infection. In addition to this the outlook for the patient depends largely upon the *cause* and *nature* of the pleurisy and the *character* of the *therapeutic management*. Many effusions may remain unresolved for years, and yet not seriously affect the welfare of the invalid. Other pleurisies, by virtue of their absorption, not infrequently produce a disastrous influence upon the general condition. Among pulmonary invalids I have noted that the development of moderate pleural effusions has sometimes been followed by most gratifying results, which had previously been impossible of attainment. The foregoing preliminary considerations will be more fully elaborated in connection with treatment.

Serous effusions are the only ones likely to become absorbed or not to reaccumulate after aspiration. Exudates which gradually assume a greater cloudiness with increasing number of leukocytes often assume eventually the characteristics of a purulent effusion, and become subject to the principles of prognosis and treatment applicable to empyema.

While serous effusions are much more benign than those which are purulent, the latter variety in many phthisical patients apparently exercises no more detrimental effect than the distinctly serous exudates. This statement applies exclusively to sterile effusions unattended by septic absorption. The prognosis varies materially, according to the specific microörganism present in the exudate, the degree of constitutional disturbance, and the nature of subsequent treatment.

The observations of Courmont concerning the seroprognosis of tuberculous pleurisies are extremely interesting. He has shown that the degree of agglutinating power of the blood in typhoid fever is comparatively small in the presence of the more virulent infections, and large in proportion to the resistance of the individual. Griffon, a few years later, demonstrated that the agglutinating power of the blood in pneumonia is greatest at the time of recovery, and almost absent in hopeless cases. Courmont and Arloing have reported that the maximum agglutination of the blood is greater, as a rule, in benign cases of pulmonary tuberculosis, and that it is slight in the desperate forms. Courmont has devoted a vast amount of study to the agglutinating power of the blood-serum and of the serous effusions in tuberculous and non-tuberculous pleurisies. He found that the non-tuberculous exudates do not agglutinate the bacillus of Koch, and that the greater part of the tuberculous fluids agglutinate tubercle bacilli in the proportion of one to five up to one to twenty. His more recent conclusions are to the effect that the prognosis of tuberculous exudates is favorable in proportion to a

high agglutinating power of the effusion, and becomes more grave with a diminution or absence of the reaction. The maximum agglutination took place as the patients proceeded toward recovery, while a diminution was found to occur as the condition became more desperate. His conclusions are as follows:

"1. The mortality is about 25 per cent. in cases the pleural effusion of which has agglutinating power, and 75 per cent., on the contrary, in those in which the fluid has no agglutinating power.

"2. Among patients with an agglutinating effusion the number of recoveries is large in proportion as the agglutination is high.

"3. One can observe the agglutinating power of the effusion increase in proportion as the case progresses to recovery, and, on the contrary, diminish in those patients in whom the termination is near."

CHAPTER LIII

TREATMENT OF SEROUS EFFUSION

To avoid confusion it is well to consider separately the management of serous and purulent effusions among phthisical patients. The treatment of serous exudates must necessarily vary in accordance with the strength and vigor of the invalid, the chronicity of the effusion, the degree of pain, the constitutional disturbance, and the extent of respiratory and cardiac embarrassment. There is no arbitrary system of management which is rationally applicable to all individuals. Each case should be regarded as a law unto itself, the therapeutic indications being determined upon the merits of the patient, as well as the effusion. Irrespective of considerations pertaining to the exudate, the course of procedure must be modified in accordance with the extent and activity of tuberculous change and the apparent effect of the effusion upon the general condition. The primary consideration relates to a determination as to whether or not the pleural involvement is doing actual harm by virtue of the pain, discomfort, fever, dyspnea, and cardiac embarrassment, or producing, for the time being, relief of cough, severe pleuritic pain, or tendency to hemorrhage. It is at once obvious that upon a correct interpretation of its influence will depend an intelligent conception of its management. In some cases it will be found best not to disturb the effusion, while in others the indications for energetic interference become highly imperative. The precise manner of procedure appropriate for patients who are little reduced physically is scarcely appropriate for those with a similar effusion but much prostrated from prolonged disease, and offering but very slight prospects for recovery from the pulmonary condition. Among many individuals the size and effect of the effusion are not sufficient to demand operative interference in order to save life. Whenever the local condition is such as to demand operations of *necessity*, even an apparently hopeless general condition should in nowise preclude the effort to render surgical aid. It is needless to state that the condition of the patient necessarily modifies in some instances not only the choice of surgical procedure, but also the nature

of the medical treatment. Active depletion, venesection, and catharsis, though of undoubted value in selected cases, nevertheless may result in incalculable injury through their indiscriminate use.

Sometimes relief of pain is urgently indicated. In mild cases this may be accomplished by counterirritation, blisters, and warm applications. Hot flaxseed poultices are occasionally productive of great comfort. If but little relief is afforded by such means, I have been in the habit of resorting to dry cupping of the chest over the seat of pain, and the results, as a rule, have been highly satisfactory. Fixation of the ribs by tight strapping with adhesive plaster often gives immediate relief. It is desirable, however, that the overlapping plaster should be drawn very tightly, each strap being not less than two inches wide. When the pain does not yield to such measures, recourse may be taken to the administration of one or two doses of morphin hypodermatically until the early suffering is in part controlled. I have observed several obstinate cases in which large hypodermatic doses of morphin repeated at short intervals have been insufficient to afford relief. In a few instances I have not hesitated to resort to free general venesection, which procedure has been followed by the immediate disappearance of pain.

In general a brisk calomel purge should be administered early, followed by the daily use of saline cathartics, large watery evacuations tending to promote reabsorption of the exudate. The salicylates have been found to induce moderate perspiration and to aid indirectly in the absorptive process. In the non-acute cases, and particularly in the absence of fever, potassium iodid is, perhaps, of some use in promoting the disappearance of the effusion. Simultaneously with efforts to hasten absorption the patients should be instructed to ingest but small quantities of liquid. It is interesting to note that among pulmonary invalids marked general improvement may occasionally take place as a result of the development of small effusions. Several years before Murphy proclaimed his treatment of tuberculosis by the introduction of nitrogen gas into the pleural cavity, it had been observed that the compression of lung by pleural effusions sometimes produced a salutary effect upon the immediate course of pulmonary tuberculosis. There were occasionally manifested a diminution of fever, improvement in cough, marked lessening of the expectoration, absence of previous pleuritic pains, and a material gain in weight. The prompt removal of the effusion by aspiration was followed in several instances by an aggravation of annoying symptoms, which were previously held in abeyance. Such procedure was frequently the precursor of an exacerbation of temperature, increase of cough and expectoration, loss of weight, and an apparent renewed activity of the tuberculous process. This would suggest the positive benefit sometimes to be derived from the intrapleural compression of lung for varying periods. It should be remembered, however, that a favorable influence does not always obtain, even in pleural effusions; that these benefits are usually but temporary, and that no artificial compression, either by gas or external contrivances, save in exceptional instances, and to fulfil special indications, is to be commended. In other words, it is not the treatment of the tuberculous lung *per se*, nor the tuberculous effusion alone, that should represent the effort of the medical adviser, but rather the management of the tuberculous individual. Laudable as have been the

attempts to secure a favorable effect upon the tuberculous process by direct mechanical compression, it must be stated that the clinical results have not been particularly gratifying. It is no detraction from the genius of Murphy to allude to the frequent impracticability of his method, and to discourage its adoption for general purposes. It remains, however, for the practitioner to take cognizance of the practical truth emphasized by his work, to the effect that in some cases an idiopathic compression from serous effusion may be, for the time being, of distinct value. To say the least, efforts to secure its immediate removal by absorption or aspiration are not invariably demanded among pulmonary invalids. The practical lesson relates to whether or not there exist *special* indications for its removal. At this juncture the advisability of exploratory puncture or aspiration must be considered.

Indications and Contraindications for Aspiration.—A very decided difference of opinion exists as to the indications for and against the aspiration of pleural effusions in pulmonary phthisis. The majority of clinicians are prone to advocate the withdrawal of the exudate as soon as the diagnosis is established. Their attitude is based upon the assumption that the longer the fluid is permitted to remain in the pleural cavity, the greater the likelihood of firm adhesive inflammation, permanent lung compression, bronchiectasis, chronic interstitial pneumonia, and deformities of the chest. Their position is apparently justified by the self-evident truth that, *generally* speaking, no individual can be expected to derive benefit from a pleural effusion, and that there is no justifiable excuse for withholding its removal until the advent of dangerous symptoms. They assume, further, that compression of lung from *any* cause is not good for the patient or the lung. It must be admitted that these postulatory statements are absolutely correct as far as they apply to non-consumptives, and even to the majority of phthisical patients suffering from *acute* pleural effusion. From the observation of many cases of pleural effusion among pulmonary invalids, both with and without aspiration, I have been constrained for some years to take exception to this as an *invariable* procedure. Consumptives should scarcely be embraced in the same category with non-tuberculous cases as far as pertains to the indications for aspiration. In the pleural effusions of pulmonary invalids a *new element* is introduced, which does not appear among the so-called idiopathic cases. The indications for the removal of the effusion are subject to considerable variation, according to the acuteness or chronicity of the exudate, the likelihood of its reaccumulation, and the general condition. Tuberculous cases should not be aspirated save in the presence of certain special indications, the mere existence of a moderate pleural effusion in a consumptive affording insufficient warrant for its immediate removal. If the effusion be sufficient in extent to occasion cardiac or respiratory embarrassment, the demand for its withdrawal is peremptory and brooks of no delay. Even the character of the effusion constitutes no *absolutely reliable* guide as to the method of procedure in consumptives. The principle of surgery that pus wherever found should be evacuated does not always hold true with reference to pleural effusions in phthisical patients. In such cases the consideration is not so much the character of the effusion, as its effect. This phase of the subject will be discussed in connection with empyema.

In order to afford greater clearness, it is well to review briefly the

manner in which spontaneous absorption is supposed to take place and the arguments that have been advanced upon pathologic grounds for its early aspiration.

Forchheimer has recently called attention to the methods by which serous effusions are removed by nature. Absorption by the veins is shown to be enhanced up to a certain point by the increased intrapleural pressure occasioned by the effusion, but later to be much diminished or entirely absent on account of the compression of the veins themselves. West, as quoted by Forchheimer, takes the ground that absorption occurs much more through the lymphatics than through the veins. He likens the pleural cavity unto a lymph-space possessing a lining of endothelial cells, the interlying stomata forming the openings of lymph capillaries which finally lead into the thoracic duct. In the presence of a large effusion absorption through the lymphatics is supposed to cease on account of the greatly diminished respiratory act and the consequent inefficient "lymph-pump." Forchheimer regards the compression of the lung by the pleural effusion as an essential factor in the diminished absorption, because of the simultaneous compression of the stomata and the lymph-vessels, as well as the veins. He thus explains the absence of absorption in less extensive effusions because of a similar effect upon the smaller portion of lung. It would seem rather difficult to explain upon this hypothesis the rapid absorption that sometimes takes place even in large effusions following the removal of a comparatively small portion of the exudate. Irrespective of the pathologic cause, it is known, however, that the larger the effusion, the less likelihood of absorption. Doerfler's work is also referred to in connection with pleural exudates of tuberculous nature. It is shown that with the prompt removal of the fluid by aspiration a preëxisting anemia, due to the compression, is followed by an artificial hyperemia. This hyperemia is claimed to be more or less permanent by reason of vasomotor paralysis, and is apparently analogous in principle to the Bier treatment of inflammations. If this be true, an increased leukocytosis is inevitable, with a resulting increased formation of connective tissue, which is supposed to inhibit to some extent the further progress and development of the tubercle. The above is the argument in favor of the performance of early aspiration in pleural effusions, and may be accepted as applicable in part to the non-tuberculous as well as the tuberculous varieties. In view of these reasons, together with the greater likelihood of permanent lung compression and the danger of sudden death, it would seem that there could be no valid ground to dispute the wisdom of prompt aspiration in all cases of pleural effusion provided there is not coëxistent such pulmonary involvement as to modify conclusions in individual instances. In some cases the condition of the patient is of more essential importance than the existence of a moderate exudate producing no subjective symptoms. The logic of clinical facts regarding the welfare of the phthisical invalid will be found more satisfying in the treatment of pleural effusions among consumptives than adherence to formulated theories. There can be no doubt as to the wisdom of aspiration in cases of acute effusion associated with fever, dyspnea, increased cough, or with the development of symptoms dangerous to life. The majority of serous effusions among consumptives, however, are of insidious origin, exhibiting a definite chronicity in their course, a tendency to reaccumulate after aspiration

and an inability to attain large proportions on account of antecedent pulmonary and pleuritic change.

In chronic effusions it is not necessary to resort invariably to aspiration in the absence of fever and dyspnea, or of such degree of mechanical compression as threatens seriously to embarrass cardiac and respiratory functions. If these conditions exist, however, removal of the liquid should be performed regardless of all other considerations.

Rules for the Performance of Aspiration.—It is unnecessary to discuss at length the modus operandi of aspiration. The necessity for the observance of aseptic rules with reference to the needle, the skin, and the hands of the operator are too well understood to warrant repetition. It is perhaps well to suggest a few simple precautions which I have found to be of considerable value. These relate to the apparatus, to the position of the patient, the site of puncture, and the technic of the operation.

1. Let it be adopted as a cardinal and invariable rule that the aspirating apparatus should be overhauled at short intervals in order that it may be constantly in admirable working order. There is nothing more humiliating to the physician than to prepare the invalid for aspiration, to subject him to the mental perturbation incident to the procedure, to inflict a certain amount of pain upon the insertion of the needle, and then discover, to his unutterable chagrin, that the apparatus is out of repair. After a troubled anticipation of the operation and an experience with the needle not to say pleasant, the invalid is unlikely to view with perfect complacency the failure of the physician to have the apparatus in complete readiness. Preparatory to each aspiration the apparatus should be examined with care and its working efficiency tested both before and after the attachment of the needle.

2. The operation should be performed with the patient in a sitting posture, either near the edge of the bed or upon a chair with a small table conveniently at hand upon which to support the receiving bottle. It is not wise to perform the operation with the patient in the recumbent position unless forced to do so in very exceptional instances. The hand of the affected side should rest upon the opposite shoulder, with the elbow thrown as far forward as possible, thus widening perceptibly the intercostal spaces. The patient should always be supported, no matter how excellent the apparent condition, and a nurse or attendant detailed to note carefully the character of the pulse during the operation. It is a good plan to administer a generous alcoholic stimulant just before the insertion of the needle. In the event of nausea and vomiting, faintness, or irritating cough, the aspiration should immediately be suspended. At such times the needle should be completely removed for the time being, although coughing will frequently subside without its withdrawal if the removal of the liquid is stopped temporarily. If coughing persists and becomes paroxysmal, it is better to cease operations altogether and reserve further aspiratory efforts for a future time.

3. Various regions of the chest have been advised as the most favorable sites for paracentesis. Some clinicians prefer a posterior location, advocating the eighth or ninth interspace in the posterior axillary line. Others aspirate in more lateral regions, selecting the midaxillary or anterior axillary line in the sixth or seventh interspace. There exists no conventional site for operation applicable to all cases of pleural effusion. Of chief importance are the accurate location

of the exudate by means of the physical signs, and aspiration over the *site* of the effusion. In large general pleural exudates the precise point of puncture is not always of material consequence. The aspiration is often easier in the more lateral regions than in the back, as the rib-spaces are wider and the chest-wall thinner. There is, however, less likelihood of injuring immediate structures if the aspiration is performed in the lower posterior region, preferably in the eighth space, in the scapular line. There is admittedly more difficulty in the introduction of the needle at this point, but if carefully inserted, the greater thickness of the muscular wall and the added proximity of the ribs are of minor consequence. The selection of the same point for aspiration is particularly advantageous in cases of small general effusions because of their invariable location at the base as shown in Fig. 95. Unless the puncture is made in the lower portion of the back, not far from the scapular line, the needle will be inserted considerably outside of the effusion. The selection, therefore, of such an area for aspiration is peculiarly advantageous for small effusions, and none the less satisfactory for the larger exudates. In a great many instances failure to observe this precaution explains a negative aspiration despite an actual existence of the effusion.

In the circumscribed pleurisies so frequent among consumptives, the preferable site for aspiration is the place where the signs suggest the presence of liquid, regardless of its location. When the signs are of doubtful interpretation, a degree of confirmatory evidence is established by the presence of local tenderness upon firm pressure, to which consideration Musser has recently called attention.

4. As to the technic of the operation, it is well to exhaust the air from the receiving bottle before the insertion of the needle. The best results, however, will be obtained by the not too rapid withdrawal of the exudate. A complete negative pressure within the bottle produces a forceful expulsive stream from the pleural cavity. It is sometimes attended by a sudden expansion of the lung, which is productive of disagreeable symptoms. Local anesthesia may be produced satisfactorily by a spray of ethyl chlorid, which, on the whole, is preferable to the hypodermic injection of cocain into the soft parts. The needle should be introduced slowly, as it is often difficult to avoid the edge of a rib. If the needle is inserted in this manner, no damage is inflicted either to the patient or to the needle, which is not always the case in the event of a sudden and forceful thrust. It is well to keep close to the upper margin of the rib in order to avoid the possible danger of piercing an intercostal artery. I have never seen this accident result, but have known of its occurrence in a single case resulting in the death of the patient, the nature of the accident being confirmed by autopsy. The distance to which the needle should be inserted is, of course, dependent upon the age of the individual and the thickness of the outer chest-wall. A considerable resistance to the point of the needle is presented by the pleura, which is frequently tough and greatly thickened. After some experience has been acquired in the performance of aspiration, the physician is enabled to recognize when the pleura has been pierced. After a portion of the fluid has been removed, the visceral pleura approaches more and more the parietal layer, and in many instances becomes lacerated by the point of the needle, unless due precaution is taken to avoid this occurrence. For this reason the needle, after its insertion, should

not be permitted to remain unsupported by the hand of an attendant or of the operator. The proximal extremity, with the attached tube, should rest gently in the open hand in order to give it support and maintain its position at a right angle to the chest-wall. In this way it is comparatively easy to recognize the instant that the visceral pleura impinges upon the point, and early opportunity is afforded for the partial withdrawal of the needle before damage is inflicted. A very slight withdrawal is advisable after the removal of about twelve ounces of liquid, in anticipation of the nearer approach of the lung to the chest-wall. It is never wise to remove over thirty-two ounces at one time, and in many cases a smaller amount is preferable. Upon cessation of the stream a recurring flow may be obtained by lifting the outer end of the needle, thus depressing the point. This sometimes occasions a little discomfort to the patient, but often permits the removal of considerably more exudate without necessitating a lower puncture. It is not advisable to exhaust the air in the receiving bottle during the act of aspiration. If the stream becomes scanty, it is well to turn the stopcock in the tube and prevent free communication with the pleural cavity before the air is further exhausted within the bottle. It is not advisable to attempt the removal of a pleural effusion without the presence of at least a nurse or attendant. Extreme faintness on the part of the patient is by no means infrequent. I recollect one instance in which, during the aspiration of a medical student, an accompanying relative who was rendering assistance suddenly fainted, and the patient shortly after experienced a remarkably severe epileptic convulsion. Fortunately, I was able to withdraw the needle without accident as the patient fell, and no serious injury was inflicted, but the lesson is apparent that the patient should always be supported and the general condition constantly noted by a competent assistant.

It is advocated by some to delay aspiration until fever has ceased, on the ground that the rise of temperature indicates a continuance of inflammatory action, and presupposes a recurrence of the effusion. If, however, indications for removal relating to the pulse and respiration are perfectly clear, aspiration should be performed regardless of fever. On the other hand, a persisting fever attending a moderate effusion without other clinical manifestations suggests the expediency of operation. Without the exhibition of so clearly defined data there is no excuse for resorting to the aspirating needle, even to the extent of an exploratory puncture. Those who regard as a myth the danger of converting a serous effusion into a purulent one by the introduction of the needle have certainly been most fortunate in their technic or have had but little experience. Several times, after a scrupulous disinfection of skin and hands, the introduction of an aseptic needle has been sufficient to convey an infection into the pleural cavity with unfortunate sequelæ. The use of the exploratory needle for purely diagnostic purposes is entirely without any justification in these cases. Given a case of pleural effusion of any nature and extent, if the clinical indications for its removal be sufficiently clear, ordinary aspiration may be employed. With the additional information secured through the gross appearance and the bacteriologic examination of the exudate, a subsequent course of procedure can be safely and intelligently conducted. If, however, upon the merits of the clinical symptoms the indications do not demand removal, meddlesome and dangerous interference should not be indulged in simply

for the purpose of diagnosis, which for the moment is relatively unimportant. Contrary to the opinion entertained by some that the character of the treatment is directly dependent upon the nature of the effusion, let it be asserted that among consumptives the question of entering the pleural cavity should be *decided strictly upon the combination of symptoms and physical signs.* In all such cases these may furnish sufficient data to constitute a safe working basis without recourse to that refinement of diagnosis which exalts the findings of the laboratory and the autopsy at the expense of the patient. If the clinical manifestations warrant the performance of aspiration, or assuming that the pleural cavity has already been entered, it is conceded that the future management is subject to some extent to the character of the effusion. The present contention is simply that among pulmonary invalids the precise determination of the nature of the liquid by routine exploratory puncture is entirely unnecessary as regards a future course of action, in view of the guidance and direction afforded by other means.

CHAPTER LIV

EMPYEMA

Clinical Manifestations.—Before proceeding directly to the treatment of purulent pleurisies it is well to call attention briefly to certain features of symptomatology and diagnosis which are especially common to this variety.

On account of the presence of unyielding adhesions, circumscribed empyema is more frequent among consumptives than among non-tuberculous individuals. Circumscribed purulent exudates may exist not only between the lung and the chest-wall, but also between the diaphragm and the lung or the separate lobes of the lung. Empyema may result from caries of rib or vertebra, serous pleurisy, or an intercurring pneumonia and typhoid. Allusion has been made to the fact that effusions of this character may be of gradual or of acute onset, accompanied in some cases with general systemic infection, and in others without the slightest evidence of constitutional disturbance. The younger the patient, the more likely are the symptoms to be acute in nature. Cases associated with systemic infection are characterized by chills, fever, sweats, and frequently leukocytosis. Cases exhibiting marked septic phenomena are usually of streptococcic, pneumococcic, or staphylococcic origin. Pain is comparatively unimportant, other than it may at times afford an indication of the probable site of the infection. Localized tenderness is of much greater importance than pain. Musser lays great stress upon firm and deep pressure in the interspaces in an effort to elicit a point of tenderness which may suggest the site of the empyema. Purulent effusions, however, often exist entirely devoid of any rational symptoms suggestive of their presence. Their early recognition necessitates painstaking examinations of the chest, which should be repeated at short intervals.

Among pulmonary invalids unilateral immobility of the chest-wall or a localized impairment of expansion is of much less significance than

among the non-tuberculous, because of other pathologic changes capable of producing a limited respiratory movement. The attention of the examiner, however, may be directed by this means to detailed physical investigation. Edema of the chest-wall is sometimes present, though not a constant accompaniment of empyema. In some cases the pus accumulation may rupture spontaneously into a bronchial tube and be discharged through the mouth in large quantities, or produce death from inundation of the bronchial tract. Rarely, the purulent exudate may point externally and be evacuated in this manner—the so-called "empyema necessitatis." Among consumptives the vocal fremitus in interlobar empyemas is vague and capable of misinterpretation, on account of the transmission of the vibrations through areas of pulmonary consolidation.

A consideration of some importance pertaining to percussion signs in such cases is the relation of the area of dulness to the interlobar septa. Musser has been particularly successful in localizing purulent empyemas by following the lines of the septa. He reports the area of dulness well below the lobar fissures in cases in which the empyema exists deeply between the lobes. Despite the absence of breath- and voice-sounds over a given area it is not especially infrequent to distinguish in these cases an increased skodaic tympany.

On account of the antecedent pathologic changes in the lung and pleura among pulmonary invalids, but little importance need be attached to the shape or location of the pleural effusion.

An auscultatory feature of special interest in connection with the small empyemas of consumptives is the remarkable frequency with which moist bubbling râles are transmitted with perfect clearness through a considerable effusion. This phenomenon has frequently led to errors in diagnosis because of the inference that the presence of loud bubbling râles is incompatible with an effusion.

Exploratory Puncture.—The possible dangers attending exploratory puncture are more practical than is usually supposed. The negative results which so often attend its employment are, to say the least, misleading, and permit of dangerous delays. This line of remark with reference to the inadvisability of paracentesis for diagnostic purposes is not to be construed as opposing aspiration with a large-sized needle whenever the symptoms and physical signs suggest the expediency of such undertaking. I would sooner resort to efficient surgical exploration of a suspicious area, provided the subjective and objective signs were sufficiently clear, than to dismiss such interference solely on the evidence of repeated negative exploratory puncture.

It is unwise, however, to accept the more or less radical position assumed by some in favor of surgical investigation, unless there is clinical evidence of an undoubted localized focus of infection. Certain it is that the chest cannot be opened and explored with the same impunity as the abdomen, on account of the possibility of inducing a dangerous pneumothorax. I will cite briefly an interesting experience which illustrates the difficulties so frequently encountered in the diagnosis and management of intrathoracic disease.

The patient was a woman of twenty-seven years who came to Colorado from Tennessee on account of suspected pulmonary tuberculosis. Her illness had been of six months' duration, following an acute onset which was characterized by severe pleuritic pain lasting nearly six weeks.

There had been much loss of strength and flesh, with constant fever and severe cough, the expectoration being purulent and amounting to about six ounces daily. Upon arrival she was markedly anemic, emaciated, and experienced moderate dyspnea upon slight exertion, the temperature ranging between 102° and 103° F., and the pulse from 120 to 130. There were almost daily chills. Upon examination the respiratory movements upon the right side were found somewhat limited. There was moderate dulness in the back from the spine of the scapula to the base; also in front from the fourth rib to the base, and in the axilla. Respiratory sounds throughout this region were enfeebled and markedly distant. There was complete absence of vocal fremitus and vocal resonance. The symptoms and signs pointed to an intrathoracic pus-collection, probably of pleural origin. Aspiration was practised in the eighth interspace in the line of the angle of the scapula with negative result. This was repeated several times during the ensuing week, until at least seven or eight punctures had been made. Despite failure to discover pus it was impossible to entertain any other diagnosis than that of an abscess within the chest. It was determined to explore the lung itself, but, owing to inability to elicit tenderness at any point, or to detect a sharply circumscribed area of flatness, it was somewhat difficult to select a site for deep exploration. The needle was inserted nearly to its full length (four inches) at a point just below and slightly within the lower angle of the scapula. Something less than an ounce of pus was withdrawn, which was found to be of streptococcic nature. One or two days subsequently rib resection was performed at this point by Dr. Charles A. Powers. Extremely firm and extensive pleural adhesions entirely obliterated the pleural cavity at the site of operation. The insertion of the needle through the deeply injected pleura into the lung resulted in the withdrawal of one-half teaspoonful to one teaspoonful of pus. A deep incision was made into the lung, and was followed by moderate finger curetage. All the lung tissue within reach of the finger was found honeycombed with very small pus-cavities. The trabeculæ were broken down as much as possible with the finger, and a single pulmonary cavity, the size of a small orange, was produced into which drainage-tubes were inserted. There was no elevation of temperature following the operation. The patient gained thirty-five pounds in weight, assumed a healthy appearance, and was sent home at the end of three and one-half months in excellent general condition, the physical signs, however, remaining practically unaltered. Advices received from her attending surgeon in Nashville, Dr. McGannon, are to the effect that her general condition remains excellent, although the abscess is discharging slightly. She has had one or two slight hemorrhages following paroxysmal cough. The site of the operation is shown in the accompanying photograph (Fig. 104), taken shortly after her return. The extent of pathologic change in the lung is seen in the skiagraph recently made. The important lesson to be learned from such an experience is to the effect that exploratory operation should be resorted to despite negative punctures, provided the symptoms and signs point strongly toward an intrathoracic pus-collection. I know this to be contrary to the teaching of many surgeons, who decline to extend operative interference in thoracic cases unless a verification of the condition is afforded by the use of the needle. It is easy to appreciate that in this case pus might not have been discovered even after numerous attempts at aspiration. In such

event the patient must have inevitably proceeded to a rapidly fatal issue.

Among consumptives a decision relative to the expediency of exploratory puncture is in many cases extremely difficult. As a general rule, routine recourse to the use of the exploring needle as a means of *diagnosis* is productive of less satisfactory results than are obtained by reserving aspiration for those cases exhibiting positive surgical indications for its employment.

Methods of Treatment.—In former years it was the general dictum of the medical profession that the treatment of all cases of empyema should be that of surgical interference, the only difference of opinion relating to the choice of method. It may be of interest to quote brief extracts from a paper prepared by me thirteen years ago, and determine to what extent one can indorse the views then entertained.

"The important practical thought to be emphasized in this connection is the recognition of the existence of several species of bacteria in

Fig. 104.—Showing site of operation in pulmonary abscess with recovery. (Compare with radiograph, Fig. 78, on p. 282.)

the exudate, endowed with varying properties and possessing marked differences in their virulence. The most benign of these characterize the empyemas of children and the metapneumonic pleurises of adults, and thereby furnish to the physician a justification for not resorting immediately, in all instances, to the more radical and mutilative measures of treatment. The therapeutic indications are conceded to be, first, prompt and thorough evacuation of the pus; second, prevention of reaccumulation by means of free and continuous drainage; third, the maintenance of asepsis; and, finally, the obliteration of the pus-secreting cavity through adequate provision for the expansion of the lung and the collapse of the chest-wall. Save in extreme cases a general tuberculous infection never contraindicates an operation from which satisfactory results are frequently obtained."

A single *preliminary* aspiration was advocated in children and in the metapneumonic pleurisies of adults. This was not based upon any

faith in the adequacy of aspiration to effect a cure, but rather with an aim to afford temporary relief, and at the same time to establish a definite diagnosis. The purulent nature of the effusion, particularly in adults, was thought almost invariably to demand subsequent operative measures. Free opening of the pleural cavity was strongly recommended on account of the complete exit offered to the coagula and organic débris, and the much improved facilities for a continuous discharge. Save for the employment of the single preliminary aspiration in children, this method was urged as an initial procedure in the treatment of all cases of empyema regardless of other qualifying conditions. It was insisted that if resection of rib was more frequently employed in the early stages of empyema before opportunity was afforded for the development of unfavorable conditions, there would result far less frequently the necessity for recourse to so severe a procedure as the multiple rib resection.

For several years the conclusions which were largely derived from the experience of others were conscientiously applied to appropriate cases of tuberculosis, with almost invariably unfortunate results. The essential principle of treatment was to perform pleurotomy, provided the general condition of the consumptive was not materially impaired, regardless of such vitally important considerations as fever, chills, sweats, and emaciation. If the condition of the patient in far-advanced phthisis was desperate, it was thought more merciful to permit him to die without inflicting the added torture of an operation. In the light of a considerable experience it has become apparent that the previous course was directly and radically wrong. Cases will be reported at length in order to illustrate the great responsibility assumed in advocating a radical operation for those comparatively well, and in withholding such surgical aid from others in urgent need, though apparently beyond hope. It is well to bear in mind that rib resection is necessarily followed by one of two conditions. There either takes place a considerable expansion of the previously compressed lung, which affords opportunity for renewed activity of the tuberculous process and rapid cavity formation, or there develops failure of the lung to expand, involving long-continued pus-formation and great danger of amyloid change. In the absence of such clinical indications as fever, sweats, and chills it seems exceedingly ill considered to precipitate the patient into the midst of such peril.

In 1895 a young man, a patient of Dr. F. C. Shattuck, consulted me immediately upon arrival in Colorado, exhibiting moderate tuberculous infection of the right lung. His illness had been of fourteen months' duration, the first symptoms relative to the pulmonary involvement beginning October, 1894. Cough and expectoration were moderate. There was slight daily elevation of temperature, with some acceleration of the pulse. Examination of the chest disclosed moist râles in the right lung from the apex to the third rib. After a period of several weeks a pleural effusion was recognized and thirty ounces of sterile serous exudate were withdrawn. Subsequently the fluid was removed many times at intervals of from three to six weeks. In the light of my present convictions this procedure was quite unwarranted. There had developed no increased elevation of temperature, no greater rapidity of pulse, or other constitutional disturbance suggesting its removal. Upon the other hand, the general condition

after the advent of the effusion was considerably improved. Chills and sweats were absent, and there was no evidence of respiratory or cardiac embarrassment. In this case the controlling indication for the removal of liquid was believed to be the continuous presence of a large inflammatory exudate, which proved incapable of absorption. It was thought that no good could result from the presence of even a sterile fluid in the pleural cavity, and possibly considerable harm from the consequent lung compression and other pathologic changes. The position was assumed that a case exhibiting progressive improvement both in the physical signs and general condition was endowed with an excellent prognosis, and hence was vested with greater responsibilities than would have been true of a less favorable condition. Accordingly, it seemed rational to prevent continuous lung compression even by a fluid thus far unproductive of subjective disturbances. It was not appreciated that a measure of the improvement in the general condition and physical signs might justly be attributed to the very fact of the compression. Unfortunately, the effusion, whether or not by virtue of repeated aspirations, finally was converted from a serous into a purulent one. This change in the character of the exudate was not accompanied by the least evidence of systemic disturbance, and upon the score of the general condition the necessity of an empyema operation was not apparent. Pus, however, was known to be present in the pleural cavity, and this was believed to constitute an imperative indication for its evacuation and subsequent drainage. Single rib resection was performed by Dr. Powers. From the standpoint of the intrapleural pus accumulation the operation was satisfactory to a degree, drainage was perfect, and the lung expanded to a very considerable extent. Judged from the basis of the individual, however, the remote effects of the operation were extremely disastrous. With the pulmonary expansion there ensued a perceptible increase in the activity of the tuberculous process. The bronchial râles became coarser and bubbling in character. Cough increased materially, and expectoration became more profuse. Fever, impairment of appetite, and emaciation were attended by rapid softening and excavation until the decline was terminated by death. The peculiarly instructive feature of this case is the fact that the improvement in the general condition was uninterrupted up to the time of the operative interference, and the subsequent retrogression rapid and relentless. After several similar experiences the conclusion has been forced that in the absence of pronounced septic infection affording distinct indications for operation, the interests of the patient are better subserved for the time being by non-interference. It goes without saying that under circumstances similar to the case just cited, it is somewhat difficult, upon the score of actual results, for the lay mind of patient and friends to acquiesce in the rationale of the operation.

Another case is that of a man, aged twenty-eight, who had resided in Colorado one and one-half years before coming under my observation, November, 1899. A progressive decline had been displayed from the beginning. He had been bedridden for several months, and a speedy fatal termination was predicted by two physicians who had been in attendance. For many weeks there had occurred daily chills, succeeded by sharp elevations of temperature, which in turn were followed by severe sweats. Cough was severe and distressing, expectoration purulent and copious, and the appetite had failed entirely.

I found the patient apparently moribund. There were extreme emaciation and cachexia. The countenance was drawn and ashen, with pinched features, the entire face being covered with cold perspiration. The pulse was exceedingly weak, scarcely palpable, and constantly over 150, while dyspnea was marked. Upon examination extensive tuberculous infection was recognized in the right lung, together with a moderate involvement of the left. A small circumscribed pleural effusion was detected at the right base, which was found by exploratory puncture to be purulent in character. Arrangements were made for an immediate rib resection, although it was believed that any effort in this direction would be utterly unavailing as far as the saving of life was concerned. The position was assumed that the sepsis and prostration were directly dependent upon the contained pus, and that the invalid, in spite of his extremity, was legitimately entitled to the adoption of the same energetic measures as a non-consumptive. The patient and family, who were quite conversant with the desperate nature of the condition, were made acquainted with the radical treatment advised. The surgeon who was summoned to perform immediate rib resection was amazed at the condition of the patient, and declined to render surgical assistance upon the ground that the invalid was a hopeless consumptive at best. In view of the fact, however, that I was committed to the operation, he reluctantly consented to extend surgical assistance, although contrary, as stated, to the ethics and principles of surgery applicable to the empyemas of far-advanced consumption. Nearly 20 ounces of pus were evacuated, and the finger inserted through the chest-wall demonstrated the circumscribed nature of the empyema. After the operation the patient remained utterly prostrated for many weeks, but a slow and gradual improvement subsequently took place. The wound closed in six months after the operation. After convalescence became established the patient was kept constantly in the open air, subjected to superalimentation, and gradually achieved a pronounced gain in nutrition. This was followed, after several years, by an entire arrest of the tuberculous process. During the past seven years the patient has devoted himself assiduously to indoor work, and the arrest of the pulmonary infection is apparently permanent and complete. Some idea as to the subsequent result may be obtained by reference to the accompanying photograph, recently taken (Fig. 105).

It is well to report another case, of more recent occurrence, which illustrates almost equally the possibilities of confusion in diagnosis, and the justification for radical operation, notwithstanding extreme physical debility. The patient, aged thirty-six, arrived in Colorado November 24, 1906, and consulted me upon the following day. Her illness had been of one year's duration, a progressive decline being characterized by distressing cough, moderate expectoration, extreme exhaustion, pallor, and emaciation. In a letter from her physician it was stated that, after a futile effort to secure improvement at home, she was sent to Colorado as a last resort, though without any reasonable hope as to her improvement. Her temperature was described as having been continuously high throughout the period of observation, and her pulse exceedingly rapid. The general appearance upon arrival was assuredly suggestive of a highly desperate condition, but some valid ground for hope was established by the recognition of a small circumscribed and irregular area of flatness in the left back, with

diminution of breath-sounds and vocal resonance. Pus was obtained upon aspiration, and the patient, despite her unfavorable condition, committed to immediate rib resection which was performed by Dr. F. L. Dixon. About twelve ounces of pus of staphylococcic origin were evacuated. Upon rallying from the operation there was manifested a remarkable improvement in all respects. Coincidently with the obliteration of the pus-cavity there was a complete disappearance of physical signs attributable to pulmonary involvement. After a gain of thirty pounds in weight, the former health was apparently restored and the mother of five young children was returned to her family.

Fig. 105.—Showing site of operation and extent of pulmonary expansion nine years after operation for empyema in a consumptive at that time apparently hopeless. (Compare with radiograph, Fig. 77, p. 281).

The site of the circumscribed empyema is represented by the percussion outlines shown in Fig. 106, which is of added interest in connection with the skiagraph showing, eight weeks after operation, an entire absence of shadow change.

To witness a rapidly progressive decline, with a fatal termination, in one who before operation was well nourished, devoid of fever, to outward appearances in good condition; to observe the astonishing recovery from an empyema in one who at first was refused operation as being almost moribund, and to note a permanent restoration to health in others, is sufficient to shake one's faith in the tenability and wisdom of previously accepted principles pertaining to a course of treatment accorded pulmonary invalids. Other equally conspicuous cases could be reported, if necessary, to demonstrate the correctness of these conclusions.

My present custom in the empyema of consumptives is to *let it alone* unless there is some good and sufficient cause for interference along the lines previously suggested. If removal is indicated, simple aspiration

is employed, and repeated as frequently as demanded. The only exception to this relates to thoroughly septic cases, exhibiting chills, fever, sweats, and great prostration. Under such conditions *no time should be lost* through temporizing measures in securing free opening and thorough drainage. Occasionally it is expedient, however, to excise the rib and drain a *small well-circumscribed* empyema even in the absence of septic manifestations *provided* the tuberculous process is very slight.

It is unnecessary to describe in detail distinctly surgical procedures. It may be permissible, however, to call attention to one or two features that have repeatedly impressed me as of great importance. First, the opening should not be too low, in order that it may not be later closed by the rising diaphragm. The pus is not emptied from the thorax altogether through the force of gravity, but is *pumped* out to a large extent by the action of the lung in inspiration and expiration. Secondly,

Fig. 106.—Photograph taken six weeks after operation. Representing the site of circumscribed empyema. (Compare with radiograph, Fig. 74.)

the opening should be maintained sufficiently patulous to permit free drainage. This does not refer alone to the opening in the chest-wall, but to the tubes as well. Many times I have seen fenestrated tubes when kept in position for a prolonged period completely occluded by a growth of granulation tissue. Third, the tube should be removed daily and cleansed, as well as shortened from time to time, in order to permit the fullest possible drainage, and to avoid the violent paroxysms of coughing produced by irritation of the approaching visceral pleura. Conspicuous relief from distressing paroxysms of cough may be afforded by frequent shortening of the tube. Fourth, daily, after removal of the tube, the patient should not merely be turned on the side, but should also be subjected to a short series of pulmonary gymnastics in various positions. This permits the fullest possible drainage, which, as a rule, is not attained by ordinary turning of the patient. Gentle coughing is often sufficient at such a time to expel violently large masses of floccu-

lent coagula, or at least to cause them to appear at the opening and allow their subsequent removal by the forceps.

Irrigation need not be employed save under quite exceptional conditions. It is permissible to irrigate with salt solution from time to time in order to estimate the total capacity of the pus-cavity, and obtain thereby some definite information as to the degree of pulmonary expansion. It is also proper to irrigate in case of a distinctly fetid odor of the pus, although fetor in itself suggests the necessity of a larger opening and of more complete drainage, rather than of irrigation. Unpleasant results have frequently been reported from the use of irrigating fluids. Such possibility may be avoided, to a large extent, provided certain precautions are taken concerning the method of irrigation. A normal salt solution or one of boric acid is the best fluid for this purpose. The use of solutions of mercury bichlorid, phenol, and similar preparations capable of undue toxic absorption is to be interdicted. Owing to the admirable drainage usually following empyema operations the liability of toxic absorption from the use of the more powerful antiseptics is indeed slight, but disastrous results occasionally follow their use. A much more serious accident from the employment of irrigation is the occurrence of shock, which in very rare instances is fatal. At times there may suddenly develop severe nervous manifestations, resulting from irritation of the pleura. Such symptoms as syncope, convulsions, hysteria, epileptiform attacks, delirium, monoplegia and hemiplegia, and disturbances of vision, though exceedingly rare, nevertheless may occur regardless of the nature of the irrigating fluid. The avoidance of untoward manifestations accompanying irrigation may be secured in most cases by proper attention to the temperature of the fluid and to the manner in which it is injected. Extremes of heat or cold are to be avoided, a temperature of about 100° F. being the most desirable. The solution should be introduced into the pleural cavity in a gentle, steady flow.

The correct application of the dressings after pleurotomy requires the observance of strict antiseptic precautions. The demand for the most scrupulous care in this respect remains continuously and rigidly in force until the final closure of the wound.

An adherence to these principles during each subsequent dressing should prevent secondary bacterial contamination. An appropriate dressing may also be of material assistance in favoring the expansion of the lung. It is very desirable that this be made to expand as quickly as possible and to the fullest extent. Should the lung become bound down by the formation of pleuritic adhesions, when in a state of only partial dilatation, its subsequent expansion is rendered extremely difficult, if not impossible.

By reviewing the mechanic principles involved in the process of lung expansion it becomes apparent that one function of the dressing should be to provide for the ready passage of the air *from* the pleural cavity, and to obstruct, as far as possible, its reëntrance.

In order to obtain a possible valve-like action of the dressing some surgeons employ external to a thick layer of aseptic gauze a piece of oiled silk large enough in size to project upon the skin in every direction, to which it is closely applied by the elastic pressure of the outer dressings.

While several theories have been presented to explain the expansion

of the lung after entrance of air to the pleural cavity, their elucidation involves a consideration of the principles of dynamics, which does not fall within the scope of this book.

It is sufficient to show that at least one element among the several that may combine to promote lung expansion is the application of an appropriate dressing. The use of the oiled silk or muslin, as described, commends itself highly in theory. It may be properly questioned, however, if a generous occlusive aseptic dressing does not answer quite as well.

In the after-treatment systematic "lung gymnastics" may be of considerable service in aiding the expansion of the previously compressed lung. The use of the James method, which consists of the transfer of water from one large Wolff bottle to another by means of the expiratory effort of the patient, is undoubtedly of some service.

The expansion of lung is aided to a considerable extent by a temporary residence in moderately high altitudes. I have had opportunity in several instances to note the excellent results obtained among cases sent to Colorado for this purpose.

CHAPTER LV

PNEUMOTHORAX

Symptoms and Physical Signs.—The pathologic conditions, as well as the symptoms and physical signs, are found to differ materially in the various forms of pneumothorax. In like manner essential differences of treatment are indicated according to the particular type of the disease. A discussion of the symptoms, physical signs, diagnosis, and treatment of this somewhat frequent complication of consumption should include, therefore, a separate consideration of the open, closed, and valvular varieties. In pneumothorax among tuberculous cases the entrance of air into the pleural cavity is effected by perforation of the visceral pleura, as the result of an underlying pulmonary cavity or subpleural caseous focus. Other ways in which air may enter the pleural cavity are of rare occurrence among pulmonary invalids. The symptoms and signs are directly dependent upon the changed intrathoracic relations, which vary in degree according to the antecedent pathologic conditions. Further, the clinical manifestations and treatment are modified by the *amount* of air present in the pleural cavity, and by certain mechanic conditions influencing the degree of positive intrathoracic pressure. Thus the character and severity of the symptoms vary according as the air passes in and out with each respiratory act, remains in a closed chamber, or, through a valvular action at the point of perforation, is pumped into the cavity with each inspiration. In ordinary cases of complete pneumothorax occurring without previous pleuritic adhesions the cardiac and respiratory embarrassment is extreme and the physical signs exceptionally well defined. Among pulmonary invalids, however, by virtue of the previous anatomic change in the pulmonary and pleural tissues, varying amounts of air may enter

the pleural cavity and produce essential differences in the clinical picture.

In partial or circumscribed pneumothorax the non-existence of typical symptoms and signs frequently leads to grievous errors in diagnosis. The classic symptoms of general pneumothorax are of sudden development, consisting of excruciating pain in the side, extreme dyspnea, cyanosis, and collapse. In addition to the agonizing pain and sense of impending suffocation there is often experienced keen mental anguish, which is reflected in the facial expression, the features being pinched and drawn. The temperature in such cases is almost always subnormal at first, but may rise subsequently. The pulse, though usually regarded at such times as very feeble, extremely rapid, and thready in character, does not always conform to this description. I have observed several invalids exhibiting extreme dyspnea, yet with the pulse but slightly affected.

Some years ago I saw, in consultation, at the request of Dr. Sewall, a case of complete pneumothorax in which all the symptoms save the slow and regular pulse suggested immediate dissolution. The patient, who had assumed the sitting posture in bed, was supported upon each side by an attendant and was rocking to and fro, moaning and screaming as much as his labored and frequent respirations would permit. There were pronounced cyanosis and excessive dyspnea. A provisional diagnosis of pneumothorax, which was entertained on the score of the abrupt onset and urgent symptoms, was verified upon examination, and the patient relieved for the time being by aspiration.

The development of pneumothorax frequently accompanies unusually severe spells of cough or sudden exertion. I have observed its occurrence several times in connection with the lifting of heavy objects, and in two instances as a result of rising upon the toes and stretching the arm to reach a chandelier.

In contradistinction to the sudden terrifying onset with pain, mental anguish, air-hunger, and varying degrees of collapse following severe cough or other obvious cause, *pneumothorax may develop in pulmonary invalids* and be entirely devoid of clinical symptoms and without visible explanation. The absence of initial symptoms does not suggest the necessity of physical exploration, and the condition often remains unsuspected until recognized at the time of a subsequent examination. I have discovered instances of pneumothorax several weeks after a careful chest examination, no intercurring symptoms of note having supervened. In a few cases it developed without symptoms or apparent cause, the patient being constantly in the recumbent position.

A case in point is that of a male patient, whose chest was examined with negative result as regards pneumothorax two days before going to bed for an acute tonsillitis. One week later, before permitting him to arise, the lungs were examined, and a well-defined pneumothorax was found. A patient, shortly before a pulmonary hemorrhage, disclosed not the slightest evidence of an existing pneumothorax, but several days after subsidence of the bleeding this condition was discovered. This seems all the more remarkable in view of the fact that morphin was freely administered and a slow respiration rate maintained throughout the illness. This case was especially interesting and instructive because of the previous existence of fibrous tissue contraction pulling the heart appreciably to the left, upon which side the pneumothorax

took place. There resulted the anomalous presence of a well-defined pneumothorax with heart displaced *toward* the affected side.

An important feature in connection with the clinical manifestations of pneumothorax in some cases is the mild initial disturbance, with a continuous increase in severity, even to the point of suffocation and death, unless relieved by aspiration. This sequence of urgent symptoms following an apparently benign onset is due to the entrance of air through a perforation of *minute size*, with, however, a progressive gradual accumulation. Upon inspiration but a slight amount of air is admitted through a patulous opening, while on account of its immediate closure the air is unable to escape during expiration. The symptoms may rapidly or slowly increase in severity in proportion to the amount of air entering the cavity with each respiratory act. Whether this difference in the *time* of development of distressing symptoms is due entirely to the size of the perforation or in part to the degree of valvular competency is difficult to determine. Certain it is that, from a clinical standpoint, cases of valvular pneumothorax exhibit an extreme variation in the onset of desperate symptoms, as well as in their recurrence following aspiration. It has been my experience that the average patient develops a sense of urgent air-hunger in two or three hours after the immense relief afforded by aspiration. I have, however, seen invalids lapse into their previous impending suffocation before the expiration of one-half hour subsequent to removal of the air. On the other hand, two patients have recently been observed in whom the entrance of air with each inspiration was so slight that the recurring symptoms were delayed for forty-eight hours after the aspiration.

The **physical signs** of pneumothorax in pulmonary invalids must vary within wide limits, according to the extent of the condition and the peculiar type present in individual cases. It should not be imagined that pneumothorax must invariably exhibit such typical signs as bulging of the rib-spaces, complete immobility of side, resounding tympany, dislocation of organs, and amphoric or cavernous respiration. Such a group of physical signs should be understood to apply solely to cases of complete pneumothorax. In such cases there may be impaired mobility of the affected side, which is compensated for by an exaggerated excursion of the other. Bulging of the rib-spaces is by no means constant, although occasionally present. The vocal fremitus, which is often described as much diminished or absent over the affected side, may even be somewhat intensified when there is a free communication with a bronchial tube. In closed or valvular forms of pneumothorax, however, the vocal resonance and fremitus are diminished very considerably.

The percussion-note varies materially in accordance with the form of pneumothorax and the quantity of contained air. In the open variety the resonance is usually tympanitic or amphoric, although the cracked-pot sound is sometimes recognized, as well as Wintrich's change of pitch. In cases of closed or valvular pneumothorax the tympanitic resonance is usually pronounced, but may be muffled in character, and the pitch more or less elevated. An excessive hyperdistention of the pleural sac incident to the contained air may give rise to marked dulness and occasion an error of diagnosis. I recollect an instructive case, seen ten years ago, the patient coming under observation some two weeks following an initial pain in the side, with gradually increasing shortness of breath. There was but little cough or expectoration. The fever was moderate,

and dyspnea well marked. Examination of the chest disclosed pronounced dulness of the entire left side, front and back, with complete absence of respiratory and voice-sounds, save in the extreme upper portion. The heart was dislocated to the right. The extreme dulness of the left side, in conjunction with other signs, suggested clearly a diagnosis of large pleural effusion, which was indorsed by two consultants preliminary to aspiration. The condition, however, proved to be one of simple valvular pneumothorax. It is important to emphasize, in this connection, the possibility of dulness upon percussion on account of the extreme tension incident to intrathoracic pressure.

The auscultatory signs are also subject to great variation in different cases. In open pneumothorax the respiration is usually amphoric or cavernous in character. These types of respiration cannot exist unless the air passes freely in and out of the pleural cavity with each respiration. Under such conditions the vocal resonance is intensified, as in pulmonary cavities. Râles are sometimes heard which possess a distinct musical quality. Metallic tinkling occurs only when liquid as well as air is present in the pleural cavity. This is also true of the succussion sign and the area of movable flatness, to which allusion has been made.

In the closed or valvular forms of pneumothorax the breath-sounds may be suppressed entirely or much enfeebled, together with the vocal resonance and fremitus.

The coin sign is of especial value in open pneumothorax, and consists of the intensified echo transmitted to the ear of the examiner from the tapping of one coin upon another placed upon the opposite side of the chest.

The **diagnosis** of acute pneumothorax, simple as it would appear, is nevertheless attended with some difficulty in many cases. A complete exploration of the chest should be sufficient, as a general rule, to establish an accurate diagnosis. There should be no difficulty encountered in recognizing the condition whenever liquid, as well as air, is present in the pleural cavity, as the signs of pneumopyothorax are so characteristic as to preclude confusion in their interpretation by an experienced examiner. The signs especially pathognomonic of pneumopyothorax will be considered in connection with that condition.

Cases of circumscribed pneumothorax are not always susceptible of easy differentiation from pulmonary cavities, as these conditions possess many physical signs in common. Among these are the cavernous and amphoric types of respiration, although the latter is more common in pneumothorax. The cracked-pot resonance is an inconstant sign, and is present not infrequently in other conditions. In pneumothorax there is often immobility of the side, with displacement of the apex-beat. The respiratory sounds and the vocal resonance and fremitus are diminished, both in circumscribed pneumothorax and over large pulmonary cavities, provided there is no opportunity for free entrance and exit of air. If there is open communication with a bronchial tube, however, there may be noted in either condition cavernous or amphoric breathing, as well as gurgling râles and pectoriloquy. Pneumothorax rarely occurs in the extreme upper portion of the chest, while pulmonary cavities may exist in any part of the lung.

The **prognosis** in pulmonary invalids varies according to the general condition, the antecedent pathologic change, the size of the air-chamber, and the particular variety of pneumothorax. Provided there is not

an immediate fatal termination, the outlook for the patient must be considered upon the basis of the chronic pneumothorax. Patients surviving the first few hours, or possibly a day, often linger for several weeks and may even recover in some instances. The prognosis attending a closed pneumothorax is unquestionably the most favorable of the three forms. The existence of this variety implies a previous rupture of the pleura, which subsequently has completely closed. Upon the basis of the physical signs alone it is sometimes difficult to distinguish this from the valvular type, although, as a rule, in the closed variety there is less immobility of the side and less bulging, while the symptoms are usually not urgent. The prognostic influence of this form of pneumothorax upon pulmonary tuberculosis is not necessarily unfavorable. The chief danger lies in the opportunity afforded for secondary infection through the entrance of microörganisms before healing of the perforation. There is at times an apparent diminution in the activity of the tuberculous infection, as a result of the pulmonary compression, the expectoration and cough often being materially lessened. If the pneumothorax is not complete, there is but slight cardiac or respiratory embarrassment. Gain in weight and disappearance of fever sometimes attend moderate compression of lung. In many cases the air is absorbed gradually, after which an advancing expansion of the lung takes place.

On the other hand, the open pneumothorax, in the majority of cases, is transformed without delay into a pneumopyothorax by the entrance of bacteria. The prognosis of these cases varies, as in empyema, according to the character of the infection and the resulting influence upon the general health. In addition to the paroxysmal cough, with copious morning and evening expectoration, symptoms of profound systemic infection may supervene. In this event the patient exhibits chills and sharp daily exacerbations of temperature, and in many instances profuse sweats. The future of these consumptives is fraught with great danger, but the condition is not necessarily fatal. Some, under prompt surgical management, finally achieve recovery, and others secure a prolonged lease of life, although succumbing eventually.

The valvular form of pneumothorax is the least favorable of all varieties. The symptoms are extremely urgent, the sufferings severe, the dyspnea intense, and the danger imminent. The immediate outlook for the patient is largely dependent upon the character of therapeutic management. Stimulation, although clearly indicated, is of but trifling value in comparison with the vast importance attached to the relief of the intrathoracic distention by removal of the contained air. Often the respite afforded by aspiration is of but a few hours' duration, and although this may be repeated at intervals, the patient is saved merely from an initial collapse. A certain number of cases, no matter how desperate the situation, finally recover through prompt and repeated aspiration accompanied by heroic stimulation. An eventual disappearance of the pneumothorax may take place in a few instances, as will be shown by the citation of an illustrative case. At best the prognosis is exceedingly grave.

Treatment.—The treatment of simple pneumothorax depends almost entirely upon the urgency of the symptoms. If extreme, the early medicinal treatment consists of excessive stimulation and the hypodermic administration of morphin. The latter is often of the utmost value, and in many cases transcends in importance all other

remedial efforts. A quarter of a grain of morphin injected subcutaneously will often mitigate to a marked extent the severity of the symptoms. As cardiac and respiratory stimulants, strychnin and atropin are recommended, together with free inhalations of oxygen. The urgency of the condition in acute general pneumothorax represents one of the few occasions when oxygen is peculiarly efficacious. The indications for treatment point solely to general measures, as morphin, stimulation, and oxygen. In open cases the efforts of the physician must be confined to the relief of pain and general stimulation, until opportunity has been afforded for the adaptation of the damaged respiratory apparatus to the functional needs of the system.

The treatment of a closed pneumothorax should relate to the avoidance of a renewed perforation, which would expose the patient to the danger of secondary infection. Absolute quiet should be enjoined for a considerable time, lest by some sudden untoward movement rupture of the pleura may result. Cough must be avoided as much as possible. To this end opiates are sometimes indicated for the time being, to meet the requirements of individual cases. If the cough is especially severe, it is good practice to strap the chest with adhesive plaster in order to restrict, as much as possible, the movement of the affected side. After several weeks' delay it may be permissible to withdraw a small portion of air under very gentle negative pressure. This procedure, however, is not to be commended in general, as even if carefully practised it may sometimes result in reopening the visceral pleura.

In acute valvular cases relief, as a rule, is secured only through the performance of aspiration, and is almost instantaneous with the withdrawal of air. This is imperatively indicated as soon as the symptoms become at all urgent. There is no conventional point of puncture to be recommended. The essential consideration is to enter the air-chamber, the limits of which are determined by the physical signs. The same precautionary measures should be observed as with aspiration of the fluid in pleural effusions, in which event no bad results attend repeated withdrawal of the air. If a considerable time elapses after aspiration before the reappearance of dangerous symptoms, the indications point to its repetition rather than to more radical measures. It occasionally happens that a few judiciously interspaced aspirations are sufficient to sustain life during the period of extreme urgency. Cases exhibiting a speedy recurrence of alarming symptoms following aspiration demand a free opening through the chest-wall into the pleural cavity. I do not hesitate in such cases to insert a large-sized trocar and cannula. The trocar is withdrawn and the cannula is fastened to the chest-wall by plaster, and covered lightly with an aseptic dressing, which is frequently changed. This method of treatment is attended by a pronounced egress of air from the chest with each expiration, and in many cases is instrumental in affording relief from most distressing symptoms. It is the treatment *par excellence* for desperate cases, and will occasionally enable the invalid to secure an adaptation to the radically changed respiratory condition. At this time the free use of oxygen as in initial open pneumothorax is of substantial aid.

In connection with the preceding principles of treatment applicable to extreme conditions the following case is of especial interest, and also illustrates the not infrequent slowness of onset.

In the summer of 1905 a young man with advanced pulmonary

tuberculosis was sojourning with his parents in the mountains of Colorado, at a point far removed from railroad communication. After several days of indisposition, shortness of breath was noted, together with moderate pain in the left side and conspicuous aggravation of cough. This was frequent, distressing, markedly paroxysmal, and unattended by expectoration. The transition from an amiable, gentle disposition to extreme irritability was a noticeable feature. Dyspnea, pain, and the nervous disturbance progressively increased during the next few days. In response to an urgent summons I found the patient after the lapse of nearly twelve hours *in extremis* by reason of a perfectly defined valvular pneumothorax. The relief afforded by aspiration was almost instantaneous, but this was again required after twelve hours. Aspiration was employed at intervals of four or five hours during the ensuing two days, and afforded in each instance a great measure of relief. The patient, however, became much exhausted from the frequent recurrence of positive intrathoracic air-pressure, and his sufferings were almost beyond endurance. The nervous control was entirely lost, and the condition became almost maniacal. During a period of two hours the pulse entirely disappeared, the skin being bathed with cold perspiration. Cyanosis was intense, and death was imminent. Against the protests of the parents, who demanded that his sufferings should be permitted to cease, I resorted to an unusual degree of stimulation with strychnin, atropin, and subcutaneous salt solution and made a free opening into the pleural cavity. A large trocar and cannula were inserted between the third and fourth ribs in the anterior axillary line. The trocar was removed, and a light, loose aseptic dressing applied over the cannula. The exit of air, which was attended by a loud hissing noise, afforded immediate relief. The cannula remained in place for three days, during which time a perceptible improvement was noted in the general condition, the respirations, and pulse. It was then removed, but replaced upon the following day, on account of the renewed development of dyspnea and cyanosis. After several days the cannula was again removed without a subsequent reappearance of urgent symptoms. A week later a small amount of air was removed by gentle aspiration, care being taken to avoid too great a negative pressure within the pleural cavity. This was repeated several times at intervals of one or two weeks. The patient greatly improved in his general condition, and at the end of three months it was impossible to detect upon rigid physical examination the slightest evidence of pneumothorax. I have refrained from devoting space to the enumeration of the physical signs in this case, as they conformed closely to the type described as characteristic of such cases.

CHAPTER LVI

PNEUMOPYOTHORAX

Physical Signs.—When, in addition to the air, liquid is also present in the pleural cavity, the symptoms common to simple pneumothorax are considerably modified. The more important differences in the clinical manifestations relate to the varying degrees of systemic

disturbance. The presence of pus in the pleural cavity often gives rise to the exhibition of chills, fever, sweats, and digestive disorders. This group of symptoms, though not invariably present in pneumopyothorax, are more frequent than in the preceding condition. The appetite is often impaired, and gastric disturbance with constipation is common. Edema of the face may be noticeable, together with slight cyanosis. There is frequently imparted a slight cyanotic discoloration to the face, which in association with pallor and edema produces a rather characteristic appearance. The ends of the fingers are usually thickened, both laterally and anteroposteriorly, and present a peculiar clubbed shape. The cough is apt to be paroxysmal and associated with the periodic expectoration of large quantities of purulent sputum. This is especially noticeable in the morning and evening, as well as upon stooping over or lying down during the day. These patients usually sleep upon the back, though sometimes upon the affected side. Turning to the opposite side may be accompanied by the expulsion of considerable expectoration. When the condition is essentially a chronic process, in the absence of systemic infection there may be lacking any rational symptoms to suggest its presence.

The physical signs, however, are strikingly characteristic, although frequently unrecognized. While the presence of air is often detected upon examination, the liquid, if occurring only in moderate amount, is not infrequently overlooked. In pneumopyothorax the upper level of the fluid conforms strictly to a horizontal plane, and being contained at the extreme base of the thorax, may escape notice if a careful physical investigation is not made at this point. By comparing the lower boundaries of percussion resonance on the two sides there should be no difficulty in recognizing an area of flatness. The disparity between these corresponding regions upon percussion is emphasized by the usual development of emphysema upon the opposite side, still further lowering its resonant border. In contradistinction to the curved line of dulness incident to pleural effusions the upper boundary of percussion flatness in pneumopyothorax is always *perfectly* straight and horizontal. A striking corroborative percussion sign is the marked variation in the level of flatness, with a corresponding change in the position of the patient. The presence of air and liquid combined in the pleural cavity is the only condition permitting a pronounced change in the upper level of percussion flatness. This is a physical sign of the utmost importance, and may be regarded as distinctly pathognomonic of pneumopyothorax.

The *auscultatory* signs are not appreciably different from those of simple pneumothorax, save that the breath- and voice-sounds are diminished or absent below the level of the liquid. Metallic tinkling, as previously described, may be recognized, and is strongly suggestive of pneumopyothorax, although occasionally heard in the presence of large pulmonary cavities containing liquid. A feature of great import is the succussion splash elicited by shaking the body quickly with one ear in direct apposition to the chest.

The **treatment** of pneumopyothorax among consumptives in the absence of well-defined septic manifestations consists of a rigid adherence to the "*laissez faire*" policy. Sometimes the indications point to the removal of the fluid by reason of its mechanic effect and the degree of septic absorption. Occasional aspiration is the most conserva-

tive means of emptying the cavity, and in some cases this measure is all that is required. Excellent results may attend the employment of siphon drainage. A trocar with cannula is inserted between the ribs, the trocar removed, and a tightly fitting rubber tube inserted through the cannula. This is subsequently withdrawn over the tube, which is left protruding into the pleural cavity. The other end of the tube is passed through the cork of a bottle, which may be carried in the pocket and emptied at intervals during the day. The flow is controlled by clamps upon the tube. I have known of several cases in which this procedure has produced highly satisfactory results. If this expedient is found impracticable, or insufficient on account of the existence of urgent symptoms, recourse must be taken to an operation which, to this class of cases, is often of direful import, *i. e.*, the permanent opening of the pleural cavity. From my observation it would almost seem that for these unfortunates the classic inscription of Dante should be changed to "Abandon hope all ye who *are entered* here." The thoroughly collapsed and atelectatic lung is usually bound down by firm adhesions, precluding all prospect of its ever expanding without removal of the visceral pleura, and even then to a limited extent. There begins at once the period of interminable suppuration and drainage, the none too cheerful prospect of repeated rib resections, after the manner of Estlander or Schede, decortication of lung, as introduced by Delorme and Fowler, or discission of pleura, as devised and practised by Ransohoff. The shock attending these major operations, the subsequent suffering, the disappointment incident to non-healing wounds, the inevitable exhaustion, and the frequent amyloid change jointly constitute considerations of sufficient import to furnish grounds for reasonable hesitation in advising these mutilative procedures. Judging solely from a considerable experience with these cases, the conclusion is reached that the results at best are likely to be unsatisfactory, although in some instances a prolonged respite is offered to the unfortunate consumptive. Perhaps a few years of this existence is preferable to an earlier death, and affords a justification for the operation in selected cases.

The dictum laid down by some authors that pyopneumothorax developing among consumptives, *regardless of other considerations,* contraindicates the adoption of radical measures is unquestionably erroneous. In the presence of sepsis, chills, fever, and sweating, the indications for immediate removal of the pus by means of a permanent opening into the pleural cavity are equally imperative as with the non-tuberculous. No matter how great the extremity, the pulmonary invalid is entitled to the same prompt measures of relief as the non-consumptive. It must be admitted, however, that the condition of the patient is a strong determining factor in a choice of the precise method of surgical interference. Even in highly desperate conditions with extreme physical debility and pronounced evidence of sepsis, aspiration alone is scarcely ever sufficient. In such cases thoracotomy is more efficacious as a means of prolonging life and promoting recovery, and also is quite as easily performed even without the employment of anesthesia. The operation consists of the introduction of a large trocar and cannula into the chest-wall, followed by the removal of the trocar and the retention of either the cannula or of a short rubber tube over which the cannula is withdrawn. Care should be taken that the end of the tube is not inserted too far within the pleural cavity. Continued drain-

age by this method is usually unsatisfactory, as the narrow rib-spaces prevent more than a small opening. The tube is very likely to become occluded by obstructive coagula of pus, blood, or lymph. When, therefore, the prompt removal of pus is demanded in profoundly septic cases, single rib resection should be performed no matter how desperate the condition. This procedure conserves the interests of the patient, both as regards the immediate present and the not too remote future. All cases permitting the administration of an anesthetic should be subjected to single rib resection in preference to aspiration or puncture, but the inadvisability of an anesthetic should not always be construed as an argument against the more radical operation. This may be performed by a skilful surgeon in an exceedingly short time without general anesthesia, as I have been permitted to observe upon repeated occasions. In desperate cases thorough preliminary cocainization of the soft parts renders the incision down to the rib perfectly painless. After denudation of the periosteum the rib may be quickly resected, either without anesthetic or with the patient under the influence of somnoform. By the use of this anesthetic Dr. Powers has recently resected the rib of one of my patients who was apparently moribund. The preliminary incision was rendered painless by the use of cocain, while the entire period of somnoform anesthesia was less than half a minute. Before the discovery of somnoform I performed rib resection with cocain in a very extreme case unsuited for general anesthesia. The operation was undertaken twelve years ago, when the condition of the patient was such as almost to demand non-interference. His subsequent general improvement was remarkable until the development of amyloid after several years. Multiple rib resection, decortication of lung, and discission of pleura are permissible only in selected cases, *months* after the preliminary opening into the pleural cavity. It is of the utmost importance that such operations be deferred until long after the initial evacuation of pus. The condition of the patient is usually such at the time of the initial rib resection as to render the case inoperable as regards the major operations. With the removal of pus and the maintenance of continuous drainage an entire disappearance of systemic infection often takes place. Opportunity is thus afforded for gain in strength and, above all, in nutrition, the value of which in such cases cannot be overestimated. After a delay of several months the patient is enabled to undergo the shock of a severer operation. Radical surgical interference, which may be unworthy of consideration at the time of the initial pus evacuation, may be attended by marked benefit six months later.

I recall the case of a patient with pneumopyothorax upon whom, at my request, Dr. Powers performed a single rib resection four years ago, and who almost succumbed from the effects of the preliminary operation. The capacity of the pleural cavity shortly after the operation, as determined by the introduction of normal salt solution, was 64 ounces. In spite of perfect drainage and daily irrigation a persisting temperature of septic type was observed during a period of five months. The infection was distinctly staphylococcic in character, and was associated with a profound purpura hæmorrhagica. Hemorrhages took place from the mouth, nose, throat, gums, and intestines, with the formation of petechiæ under the skin. About two months following the first operation, in the midst of an exceedingly poor general condition, a large

counteropening was made in the chest-wall. Despite perfect drainage, secured by the daily passing of sterile gauze from one opening to the other, there ensued no resulting improvement. During the following three months there occurred morning remissions, with sharp evening exacerbations of temperature, with daily chills and sweats. There was marked emaciation, with weak and extremely rapid pulse. At this time I decided to substitute iodoform gauze for that previously used. This was drawn from one opening to the other and the pleural cavity freely packed. The temperature receded to normal upon the second day, and remained so for ten days. In order to avoid any misconception as to the effect of the iodoform, I reverted once more to the use of the sterile gauze. This was followed by an immediate elevation of temperature, which persisted several days and receded at once upon a return to the iodoform pack. It is, of course, recognized that a single case of this kind must not be accepted as establishing a direct relation of cause and effect, as regards the employment of the iodoform pack. Improvement was progressive and rapid

Fig. 107.—Marked unilateral deformity following Schede operation for pneumopyothorax. Note lower edge of lung upon the right side. Compare with figures 75 and 76.

from this time. Nine months after the rib resection the patient, having gained thirty-five pounds in weight, a Schede operation was performed by Dr. Powers, which reduced the capacity of the pleural cavity to four ounces. The patient is now in excellent condition, the discharge being almost nil and the cavity holding but one and one-half ounces of salt solution. Figs. 107, 108, and 109 are of interest in showing the amount of deformity resulting from the multiple rib resection to effect an obliteration of the pus-secreting cavity. This would have been completely out of the question as an early operation.

The extent of the operation must depend largely upon the size of the cavity and the age of the patient. The operation is rarely demanded in children on account of the greater elasticity of the thorax. Among adults, however, the rigidity of the chest-wall presents an insuperable obstacle to the obliteration of the suppurating space, and in the absence of lung expansion the resection of ribs becomes the only rational procedure. The removal of a large portion of the bony thorax permits the

apposition and cicatrization of granulating surfaces. It is scarcely pertinent to the purpose of this book to enter into a discussion of the

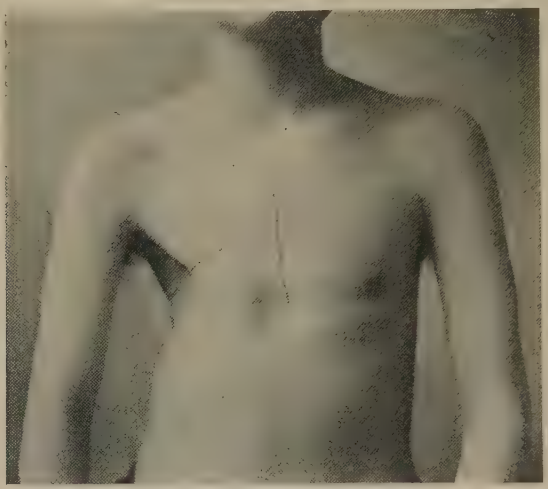


Fig. 108.—Same patient as Fig. 107, showing the lower edge of the lung in front and the swinging of the sternum toward the unaffected side.

comparative merits of the Estlander or the Schede operation, or to attempt a description of the technic.

Decortication of the lung, as introduced by Delorme, consists of the removal of the visceral pleura from the lower half of the collapsed and

Fig. 109.—Photograph of same patient as Figs. 107 and 108, showing extensive cicatrization, site of remaining sinus, and also boundary of lung in the lateral region.

atelectatic lung, which permits, to a very considerable extent, its subsequent expansion. This operation has been found to be much safer

and more easily performed than the attempted removal of adhesions between the costal and visceral pleura. The operation is sometimes practised in connection with Schede's multiple rib resection, in which event the skin-flap coalesces and cicatrizes with the denuded lung. In other cases a trap-door operation is performed, which includes the lifting of a portion of the chest-wall, permitting free access to the collapsed lung and the denudation of its pleura. Subsequently the trap-door is replaced and provision made for adequate drainage.

Discission of the pleura was devised and performed by Ransohoff, and has yielded fairly satisfactory results. This procedure consists of free incisions of the pleura carried downward to the lung proper.

SECTION III

TUBERCULOSIS OF THE PERICARDIUM AND PERITONEUM

CHAPTER LVII

TUBERCULOSIS OF THE PERICARDIUM

Etiologic and Pathologic Data.—This condition, on account of its relative infrequency, is of much less importance than tuberculosis of the pleura or peritoneum. It is, however, considerably more common than generally supposed. The clinical evidences of tuberculous involvement of the pericardium are exceedingly obscure.

The position and size of the heart may be outlined with reasonable accuracy during life by a skilful examiner, and the results confirmed or modified by *x*-ray examination, but the only reliable data as to the frequency and nature of the pericardial complications in pulmonary tuberculosis are furnished by autopsy findings. To be of definite value it is obvious that the postmortem study should be conducted by a trained pathologist, and embrace a large number of autopsies upon tuberculous subjects. Only by means of such investigations are there afforded correct conceptions as to the prevalence of the condition.

During the first two years of the existence of the Phipps Institute for the Study of Tuberculosis there were conducted 143 autopsies, 88 of which were performed in the first year. Of the 88 autopsies, there was but 1 case of typical miliary tuberculosis with pericardial involvement. There were, however, 3 cases out of the 143 autopsies during the two years. Of the total number, there were reported 3 cases of local pericardial adhesions, 1 instance of general pericardial adhesion, 1 of thickened pericardium, and 8 of total obliteration of the pericardium. Only 1 case of acute serous pericarditis was found. Evidence of pericardial involvement of some kind was obtained in 18 cases out of 143, including both acute and chronic varieties. Actual tubercles were found in only 3 instances, and it is, therefore, more or less problematic whether or not the other cases were of actual tuberculous origin. It must remain a matter

of conjecture if the cases of chronic obliterative pericarditis and those with local adhesions were directly occasioned by tuberculous infection. It is reasonable to believe, however, that nearly all low-grade chronic inflammations of the pericardium among pulmonary invalids owe their existence to tubercle deposit. If the tuberculous character of nearly all idiopathic pleurisies is admitted, even among apparently non-tuberculous subjects, it is safe to assume that a similar involvement of the pericardium may occasionally take place among phthisical patients.

The autopsy report with study of heart lesions at the Phipps Institute was made by Drs. White and Norris.

In the third annual report, recently issued, there is contained a record of 57 autopsies conducted during the past year upon phthisical patients, with practically negative pericardial findings. Thus, out of 200 autopsies reported in three years, but 3 cases of miliary involvement of the pericardium were found, and 8, or 4 per cent., of obliterative pericarditis. During the first year White reports the latter condition in 3.4 per cent. of the cases recorded, and submits for comparison obliterative pleurisy of both sides in 4.5 per cent. of cases—the left side, 19.5 per cent., and the right in 17 per cent. Of the pericardial cases, one coëxisted with obliterative pleurisy upon each side, one with right-sided pleurisy, and one with general adhesions on both sides. No histologic investigation was made to determine precisely the tuberculous origin of the adhesions. Norris, in 1904, collected statistics concerning pericardial involvement in 1780 autopsies upon tuberculous subjects, and, exclusive of doubtful cases, found pericarditis, which was presumably tuberculous, to have occurred in 4.6 per cent.

Although the pericardium occupies a more or less protected position as far as opportunity for secondary infection is concerned, it is not surprising that tuberculous involvement should supervene on account of the existence of tuberculous processes in adjacent structures. The condition may originate from neighboring foci of infection in the pleura, lungs, mediastinal glands, and from caries of some part of the bony intrathoracic wall, notably the sternum, ribs, and dorsal vertebra.

In a large number of cases the symptoms of tuberculous pericarditis are entirely latent during life. At times there are present the usual manifestations of general miliary tuberculosis, without distinct evidence of pericardial involvement. It may exist clinically as the ordinary acute form of pericarditis, either of the dry variety or accompanied by effusion. Another group of cases may be expected to exhibit the symptoms of functional incapacity associated with dilatation and hypertrophy, which result in many instances from the existence of chronic pericardial adhesions. The two latter varieties are of especial interest, one pertaining solely to an acute pericardial condition, and the other relating to adherent pericardium, with possible changes in the size and position of the heart and accompanying circulatory disturbance.

Varieties.—Acute tuberculous pericarditis which is likely to be overlooked clinically may exist in two forms—the dry plastic variety and the type characterized by effusion. The exudate may be serous, serofibrinous, purulent, or hemorrhagic. The more common form is the plastic pericarditis, which may be unattended either by subjective symptoms or physical signs. The serous membrane may present but a dull, slightly roughened appearance, or a shaggy, irregular fibrinous coating. The fibrinous exudation upon the internal pericardium varies

much in thickness, and successive layers of lymph sometimes completely cover the macroscopic evidences of tubercle deposit. The thickened membrane may be infiltrated with tiny yellowish-gray tubercles, or granulations may exist between the layers which later become confluent. Upon gross inspection there is often no evidence of tubercle deposit, but the tuberculous character of the process may be readily demonstrable, despite a normal macroscopic appearance.

Symptoms.—The only subjective symptom of the acute plastic form of tuberculous pericarditis is pain, and this is not always present. It is rarely intense, although in exceptional instances quite distressing. The pain is usually referred either to the precordial region or to the tip of the ensiform appendix. It is sometimes sharp or stabbing, and occasionally synchronous with the cardiac pulsation. But little significance is to be attached to the presence of fever unless this develops in conjunction with pain and objective signs.

Upon palpation there is sometimes recognized, synchronous with the heart contractions, an appreciable fremitus to the left of the sternum between the third and fourth ribs. The important auscultatory sign is the to-and-fro friction-sound. This may be creaking, grazing, rubbing, or grating in character. It is more frequently a rub, and gives the impression of coming from directly under the stethoscope. These superficial sounds are usually intensified by increased pressure upon the skin with the bell of the instrument. They may be heard at the base, but the more frequent site is over the right ventricle. A peculiar feature of the friction-sounds is their inconstancy, as they are often recognized at one time and not at another. They are distinguished from the pleuropericardial friction-rub by the difference in rhythm and the influence of the respiratory movement. There is but little difficulty in differentiating the distinct rubbing character of the pericardial sounds from the soft blowing endocardial murmurs. This form of tuberculous pericarditis may terminate in effusion, or the condition may be changed into that of adherent pericardium, owing to the fusion of the serous surfaces through connective-tissue proliferation.

The symptoms of tuberculous pericarditis with effusion are extremely variable, and, as a rule, are unpossessed of special significance. In many cases they are entirely absent for prolonged periods, and the condition escapes recognition altogether. At other times the diagnosis is made purely through recourse to the objective signs. It is not unusual for symptoms previously latent, suddenly to assume an aggravated character. Marked dyspnea, pain, pallor, or cyanosis may quickly supervene upon a period of ill-defined malaise, slight shortness of breath, and tendency toward fatigue. Thus the development of the condition is occasionally found to be decidedly insidious, without exhibition of clinical manifestations, until the effusion has attained such size as to permit pronounced physical signs. On the other hand, the onset is not infrequently acute and attended by well-defined symptoms, even before the recognition of pericardial exudation. Often complaint is made of pain, which may range from a sharp, agonizing stab to a mere sense of oppression referred to the precordia. The pain may be increased upon pressure at the lower end of the sternum. A beginning shortness of breath in acute or subacute cases rapidly changes to a marked dyspnea, which necessitates a maintenance of the upright or semireclining posture. The patient is distinctly restless, and the expression anxious.

There is almost always pallor or slight cyanosis. The alæ of the nostrils, particularly among the young, are seen to dilate with each respiration. As the restlessness increases insomnia or delirium may supervene. I have seen marked hysteria, melancholia, and chorea develop in severe cases, and have recently observed pronounced stammering during the height of the effusion, and persisting for weeks after its removal. The pulse is always rapid and frequently irregular. Many observers have described the pulsus paradoxus, characterized by an extremely weak and feeble pulse, during inspiration.

Upon inspection there is more or less circumscribed prominence over the precordial region, with bulging of the intercostal spaces and in some cases edema of the chest-wall. Sometimes the respiratory expansion of the left chest is notably diminished. In very large effusions a prominence in the epigastrium may be produced by the downward displacement of the left lobe of the liver. The apex impulse may be feeble or entirely absent. Upon palpation the apical impulse is frequently obliterated completely, particularly in the event of a large effusion. Though displaced in some cases, its position in others is unaltered. The percussion signs are of especial importance, chiefly with reference to a gradual increase in the area of cardiac dulness. The lungs offering but little resistance to the encroachment of the pericardium are correspondingly compressed. There is considerable difference of opinion as to the configuration of the dull area, many writers being in the habit of describing the outline as irregular or pyriform in shape, with the narrower portion pointing upward toward the manubrium or the left sternoclavicular notch. For practical purposes, in outlining this area in pericardial effusion, it is quite justifiable to disregard any presupposed idea as to its pyramidal shape. The essential consideration as far as the percussion outline is concerned, is the more fact of a symmetric enlargement of the area of dulness in all directions. In extreme cases this may extend far to the left of the left nipple, to the right well beyond the right border of the sternum, and upward as far as the clavicle. When the outline at the base and lower lateral regions is suggestive of a pyramidal form, the upper portion is usually somewhat truncated, the upper border rarely conforming to an apical outline. In beginning small effusions the changes in percussion resonance to the right relate to an increasing dulness over the sternum from the fourth to the sixth rib. As the effusion increases and the dull area encroaches more and more to the right of the sternum, the diminished resonance is noted in the neighborhood of the sixth rib.

Much attention has been directed to the so-called *Rotch sign*, which consists of the obliteration of the cardiohepatic angle. This sign is not always easy of exact determination, simple as it may seem, and to the general practitioner is not of especial value. Ewart has called attention to a quadrangular patch of percussion dulness in the left infrascapular region. Bamberger's sign consists in the diminution of percussion resonance in the lower axilla, and about the angle of the left scapula, owing to pulmonary compression. While it is possible occasionally to detect an increased dulness in the left axilla, it must be conceded that Bamberger's sign and Ewart's sign are of doubtful value in the average case. Change in the area of percussion dulness is sometimes produced by a change in the position of the patient.

The most important auscultatory sign is the progressive enfeeble-

ment of the heart-sounds, which in some cases become scarcely audible. Preëxisting endocardial murmurs are usually found to disappear with an increasing effusion. Worthin calls attention to the frequent accentuation of the pulmonary second sound. Friction-rubs heard early in the case disappear with the development of the effusion, though they are sometimes audible at the bases.

The **course and prognosis** depend largely upon the character of the effusion. As a rule, the progress is slow and tedious in tuberculous pericarditis, though in serous effusions the exudation may be absorbed with considerable rapidity. Absorption may take place to a certain extent even with purulent effusions, but the outlook is by no means good in such cases.

The **diagnosis** of tuberculous pericardial effusion is often attended by the greatest difficulty. The observant clinician who has been permitted to watch the case from the beginning and to note the gradual but progressive development of physical signs, is far more likely to arrive at an accurate diagnosis, than the consultant who is called upon to differentiate between moderate or large-sized pericardial effusion and extreme cardiac dilatation. At such time a correct determination of the condition is frequently impossible without recourse to paracentesis. It is not infrequent that the most skilled examiners are found to be in error under these conditions.

Attention has been repeatedly called to the wavy character of the cardiac impulse in dilatation, and the shock or slap of the cardiac sounds. In dilatation the area of dulness does not extend upward as far as in effusion, and the heart-sounds are less indistinct or muffled. Important points are the disappearance, in effusion, of a previously recognized endocardial murmur, and the change in the area of cardiac dulness upon change of posture. Osler calls attention to the fact that in dilatation the distention is rarely sufficient to compress the lung and produce percussion changes in the axillary region. I have seen this result, however, in a notable instance of cardiac dilatation in which there was even sufficient pulmonary compression to occlude entirely a primary bronchus.

Extreme difficulty of diagnosis may be presented in some cases despite an intelligent review of the symptoms and physical signs. Even paracentesis does not invariably afford a positive conclusion concerning the pathologic condition, as will be illustrated by the following report of a case recently under observation:

The patient was a delicate child, ten years of age, with a distinct family history of pulmonary tuberculosis, although no physical evidences of a tuberculous process had thus far been recognized. I was summoned at the end of a period of malaise and lassitude of one week's duration. The temperature was 102° F., pulse 108 and of good quality. The child was dressed and reclining upon a couch in the open air, but manifested a disinclination to sit up. The expression was dull and the face markedly pale. Complete physical examination was negative. The child was put to bed immediately and a liquid diet instituted. The bowels were thoroughly moved, and the salicylates with potassium citrate administered. Upon the third day a faint mitral systolic murmur was heard at the apex, coincident with a distinct to-and-fro pericardial friction-sound over the right ventricle. There was slight precordial discomfort, but complaint was made of severe pain in the left shoulder. Upon the fourth day the pain continued sharply localized in the shoulder,

but was also intense over the region of the heart. The patient was restless, and the suffering difficult to control in spite of hypodermics of codein and finally of morphin. Meantime the temperature had risen to 104° F. and pulse to 130. The bowels were obstinately constipated. A beginning dyspnea was noted in connection with slight cyanosis. The pericardial friction-sound disappeared at the end of twenty-four hours, but the endocardial murmur persisted for several days. A diagnosis of pericarditis had been rendered, and a blister two inches square produced over the precordium. This was attended by considerable benefit for about a day and a half, during which time the child was thoroughly purged with calomel. Appeal was made to the skin and kidneys, and cardiac stimulants cautiously administered. A progressive increase in the area of cardiac dulness was noted. Impaired resonance was recognized well to the right of the sternum and to the left of the left nipple, with a continual upward rise of the area of dulness. The pain over the precordial region increased in severity and the child became hysteric and almost unmanageable. The dyspnea was pronounced, as was also the cyanosis. The respirations were nearly fifty to the minute, the alæ of the nose dilating markedly. The cardiac impulse became much enfeebled, and finally disappeared altogether. The heart-sounds were distant and muffled. With the increase of effusion the endocardial murmur became more indistinct and was finally incapable of recognition. Despite active cardiac stimulation the condition became extremely desperate by the end of one week. There was orthopnea, insomnia, excruciating pain over the heart, a temperature ranging from 104° to over 105° F. at all hours of the day, with a pulse of 144 to 150, and of exceedingly poor quality. The cardiac dulness extended to the second rib, slightly over an inch to the right of the sternum, and an inch and a half to the left of the left nipple. The diagnosis appearing unquestionable, I determined to perform immediate paracentesis of the pericardial sac. Before resorting to this procedure I requested counsel and received a confirmation of the diagnosis and indorsement of the aspiration by Drs. Hall, Powers, and Emery. The puncture was made by Dr. Powers in the fifth interspace, an inch and a half to the left of the left margin of the sternum. The needle was inserted not over three-quarters of an inch. The aspirated fluid presented all the appearance of pure blood, of which twelve ounces were withdrawn. Coagulation of the blood took place in the receiving bottle before the aspiration was completed. Despite our consternation at the sight of a fluid which scarcely could be described as a sanguineous exudate, but rather as blood from a ventricle, the aspiration was continued as long as the flow persisted. The natural impulse upon the first appearance of the blood to withdraw the needle was restrained, chiefly because there was no visible movement of the needle, as might be expected in case the ventricle was pierced. While it was conceivable that in the event of a greatly dilated heart the vascular contractions might impart but slight movement to the needle, complete absence of impulse suggested that the point remained within the pericardial sac. This conclusion was strengthened by the knowledge of its comparatively superficial insertion. The improvement in the child's appearance and respiration was immediate and pronounced. He also experienced decided relief from pain. Directly following the withdrawal of the needle I outlined with care the area of heart dulness, and the result was corroborated by the other physi-

cians present. The size of the heart was found to be reduced remarkably, as shown by Fig. 110, which is taken from a photograph illustrating the lines of cardiac flatness immediately prior to and following the operation. A record was taken of the boundaries of cardiac dulness and the outlines were indicated upon the chest following recovery. The temperature was $104\frac{3}{5}°$ F. at the time of operation, and at the end of six hours had dropped to 101° F., with corresponding improvement in the pulse and general condition. Shortly after the aspiration a returning endocardial murmur was recognized, together with greater distinctness of the heart-sounds and a gradual reappearance of the impulse. The aspirated blood was found by Dr. W. C. Mitchell to be absolutely sterile upon bacteriologic examination.

During the next few weeks the child improved progressively in all respects, the temperature finally receding to normal, and the pulse remaining in the neighborhood of from 96 to 108. Pain entirely disappeared, as did dyspnea, cyanosis, and all other subjective symptoms.

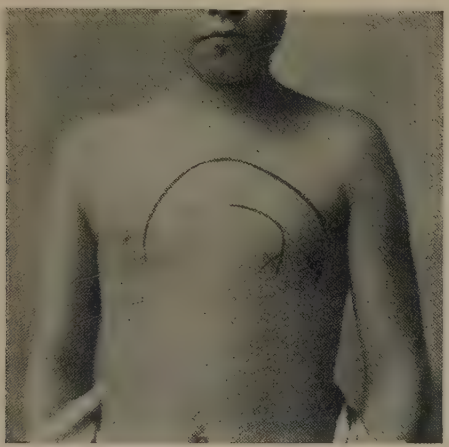


Fig. 110.—The upper and outer line represents the area of cardiac flatness before aspiration for suspected pericardial effusion. The inner line shows area of flatness immediately after removal of twelve ounces of blood.

There persisted, however, a loud systolic murmur at the apex, with a noticeable wavy cardiac impulse. The dull area then extended slightly to the right of the sternum and half an inch to the left of the left nipple. It would appear that were the child to be seen for the first time under these later conditions, the diagnosis of dilatation would be almost unavoidable. I was forced to assume that regardless of what the previous condition might have been, the heart was now moderately dilated. Although the child was improving steadily, I decided at the end of one month following the operation, to relieve the heart as much as possible by sending the patient to a lower altitude, and at the same time to give him the benefit of the Nauheim treatment. He was accordingly referred to Dr. Babcock, of Chicago, under whose supervision he remained for six weeks. The child has continued to improve steadily since his return to Colorado, and at the present time, one year after his initial attack, shows no evidence of dilatation and but a scarcely perceptible endocardial murmur. The question arises, did the child have originally a

pericardial effusion consisting of pure blood, which coagulated immediately, or was the blood withdrawn from the ventricle? Irrespective of the diagnosis there can be no doubt that life was saved by the operation, and that even ventricular aspiration is rational treatment for an extremely dilated heart.

Opinions may differ as to the actual condition which existed in this case. It is certainly unusual to remove a fluid from the pericardial sac presenting all the gross appearances of blood with its nature confirmed by examination. On the other hand, it is equally difficult to reconcile certain features of this case with the presence of a dilated heart. The early symptoms and physical signs were distinctly those of an increasing pericardial effusion. The shape of the dull area corresponded to the expected outline of effusion. The muffling of the heart-sounds and disappearance of the murmur before the aspiration, with subsequent return, lend color to the accuracy of the diagnosis. This is further strengthened by the absence of movement imparted to the needle, the short distance of its insertion, and the immediate reduction in the size of cardiac dulness. On the other hand, it is almost indisputable that the heart was distinctly dilated two weeks after the aspiration and remained so for a month or six weeks. It would seem that if the original diagnosis of effusion is correct, the only rational explanation of the resulting dilatation is found in the formation of epicardial and pericardial adhesions, of such extent as to embarrass the cardiac movement and occasion temporary dilatation. The difficulties attending a definite diagnosis, regardless of possible tuberculous infection and the responsibilities involved in the adoption of pericardial paracentesis, are better appreciated through the force of a vivid experience than by the perusal of classics pertaining to the differential diagnosis.

Treatment.—Rest constitutes the essential feature of treatment of pericardial effusions, whether or not tuberculous. Medicinal measures are of doubtful efficacy. Many cases improve without other treatment than absolute rest, and others are found to go from bad to worse, irrespective of the nature of the therapeutic agencies employed. Opiates are indicated for the relief of pain and sometimes to promote sleep. I am satisfied that their application in such cases is more rational than the indiscriminate administration of hypnotics, which are likely to depress the heart to a certain extent. Although blisters are considered inadvisable by some writers unless the signs of effusion have become very apparent, it is, nevertheless, excellent practice to resort to their use early in the disease. I can see no possible objection to their employment after the diagnosis has been determined, and but little to be gained by delaying until the effusion has become of large size. It appears that their efficacy is largely dependent upon the time of their employment. It is not clear that recourse to a blister interferes materially with a close study of the physical signs, and rarely with pericardial puncture. Active purgation is not always permissible, but is sometimes indicated in fairly robust patients. In early stages the application of the ice-bag over the region of the heart is of some value, and often affords considerable relief to the precordial discomfort. Salicylates are of doubtful utility, and when pushed indiscriminately, are apt to depress the heart. In such cases potassium iodid is one of the best cardiac sedatives.

There is a wide difference of opinion as to the site of election in

making the pericardial puncture. The left costoxiphoid angle is preferred by many, who thrust the needle upward and backward from this point. This site is more satisfactory in case of extremely large effusions than under other conditions. The fourth interspace at the left sternal margin or at an inch and a quarter from the margin, as well as the fifth interspace an inch and a half from the edge of the sternum, are respectively advised. Some clinicians in the presence of large effusions are in the habit of aspirating to the left of the left nipple, the effort being made to insert the needle just inside the outer left border of dulness. Personally I am not able to indorse aspiration other than through the small area over the ventricle where the lung does not come in immediate apposition to the chest-wall.

In the event of a purulent effusion surgical measures should be immediately instituted. They consist of free incision, sometimes resection of rib, and the maintenance of continuous drainage, affording a thorough evacuation of thick pus and coagulable flocculi.

ADHERENT PERICARDIUM

There are two forms of adherent pericardium. In one group there is present a simple adhesion of the pericardial and epicardial layers. In these cases the surrounding structures are frequently uninvolved, although there may be a considerable union of the two layers. In another group adhesions are formed between the outer layer of the pericardial sac and the chest-wall, diaphragm, and pleura, by virtue of their immediate contiguity. The parts may be fused closely together and be associated with more or less mediastinal connective-tissue formation.

The symptoms incident to the presence of pericardial adhesions, irrespective of other cardiac lesions, vary according to their extent and situation. In the event of simple adhesions of the two layers of the sac there may be no symptoms whatever, although hypertrophy occasionally may result. Dr. Babcock has called attention to the occasional union of the two surfaces of the pericardium during the time the heart is acutely dilated, either as a result of myocarditis or of valvular disease. Under such circumstances its complete diminution in size is almost impossible, and a disturbance in its function is quite inevitable. When the adhesions are external to the sac and involve neighboring structures, the condition is of much more serious import, owing to the unavoidable restriction in the movements of the heart and consequent embarrassment of its function. Hypertrophy, dilatation, and circulatory stasis are frequent. There are often palpitation, dyspnea, bronchial irritation with weak pulse, and digestive disturbance. The liver is sometimes enormously enlarged from passive congestion. In some cases, however, the liver becomes much reduced in size through connective-tissue proliferation, and the condition may suggest chronic interstitial hepatitis.

The physical signs upon inspection relate to the prominence of the precordium, and a more or less extensive diffusion of the cardiac impulse, with occasional displacement of the apex. The impulse is often undulatory over a wide area, transgressing frequently the limits of the normal precordial region. In some cases there is immobility of the apex impulse, either with a change in the position of the body or during full inspiration. During systole a tugging retraction of the chest-wall is commonly noted in the lower left epigastric region. This may be

followed by a diastolic rebound of the interspaces immediately over the point of apex retraction.

Broadbent's sign consists of a visible systolic retraction of the chest-wall, not only in the region of the seventh or eighth ribs in the left parasternal line, but also between the eleventh and twelfth ribs on the left side behind, at the point of attachment of the diaphragm.

Friedreich's sign consists of the diastolic collapse of the cervical veins ascribed to the sudden emptying of these vessels as a result of the expansion of the chest-wall.

A paradoxic pulse, though less common than in acute pericarditis, is sometimes recognized upon palpation, owing to the traction of the cicatricial mediastinal tissue upon the aorta during inspiration.

The percussion signs relate to an increase in the area of cardiac dulness, owing to hypertrophy and dilatation, which may be extreme. Irrespective of the presence of endocardial murmurs, which are occasionally dependent upon the dilatation, the important auscultatory signs are the pleuropericardial friction-sounds. These sounds may be heard both with inspiration and expiration, and, as a rule, are distinctly creaking in character. It is not infrequent to find the sound considerably more intensified during inspiration than expiration, and sometimes vice versâ. It often disappears, however, upon holding the breath. It is heard to best advantage over the left border of the heart.

The exact determination of cardiac hypertrophy or dilatation among pulmonary invalids is often a matter of *extreme difficulty*, even by most skilled examiners. From a comparison of the results of my own clinical findings with the skiagraph I have become convinced, first, that the *heart is displaced very much oftener than would be imagined from the literature upon the subject*, and, secondly, that the ordinary methods of percussion and auscultation are sometimes quite insufficient to afford an accurate determination of its position and size among this class of patients. This has been discussed more fully in connection with Diagnosis.

CHAPTER LVIII

TUBERCULOSIS OF THE PERITONEUM

Tuberculosis of the peritoneum may exist as one of the local manifestations of acute miliary tuberculosis, or as a distinct peritoneal process of more or less chronic character. When the condition is incident to a general miliary infection, the tubercles are diffused over the parietal and visceral layers of peritoneum, without, as a rule, any active inflammatory change. When tuberculous peritonitis exists as a local condition purely, the inflammatory condition may be accompanied by various pathologic processes. In some cases there is an extensive proliferation of connective tissue with numerous adhesions between intestinal coils and adjacent viscera, with occasionally an implication of the abdominal walls. In others with less tendency to adhesions there is found a pronounced thickening of the peritoneum, omentum, and mesentery incident to their infiltration with degenerative tubercle deposit. This form is sometimes

characterized by the presence of large ulcerative tuberculous masses. Palpable tumors simulating tuberculous growths are produced by a localized matting and drawing of the intestines, which is intensified in some instances by the traction exerted by a shrunken mesentery. In still another group of cases there is a profuse exudative process. This may be unassociated with marked pathologic changes within the peritoneal cavity, or it may attend the proliferative type, with multiple adhesions, or even the caseous and ulcerating forms. The exudation may be serous, seropurulent, or bloody in character, and may be general or sacculated. A simple general ascites of insidious or very acute onset without subjective symptoms may accompany a developing tuberculous deposit unattended by other pathologic change. In some cases the exudative processes are found in association with extensive connective-tissue change. It is manifestly improper to divide all cases of tuberculous peritonitis, aside from the miliary form, into two distinct classes —the proliferative and the exudative groups—as has been attempted.

The **etiologic relations** of tuberculous peritonitis have been the subject of much clinical study and investigation. The condition is almost always secondary to some other tuberculous focus, the primary source of infection being traced to the lungs in the large majority of cases. At least four-fifths of all instances of tuberculous peritonitis occur in association with easily recognized pulmonary involvement. Cummins has reported a series of cases in which 84 per cent. succeeded pulmonary tuberculosis and 32.6 per cent. intestinal involvement. The same observer has quoted Pribram's report of the result of 165 autopsies upon cases of tuberculous peritonitis, of which 87 were attributed to intestinal tuberculosis, 65 to glandular disease, 8 to tubal and uterine, and 5 to osseous tuberculosis. Douglass has quoted Borschke, who failed to find a primary focus in but 2 cases out of 226 of peritoneal tuberculosis. From a total of 1393 autopsies upon tuberculous subjects, tuberculous peritonitis was found to exist in 226 cases, or 16 per cent. Peritoneal involvement in tuberculous invalids has been reported by other observers to vary from 10 per cent. to 20 per cent.

Tuberculous peritonitis may exist at any time of life, although observed more frequently in young adults. When occurring in children, it is often in association with a general miliary involvement. Frederick C. Shattuck has recently reported some statistical observations upon a series of 98 cases of tuberculous peritonitis treated at the Massachusetts General Hospital during a period of eleven years from 1889 to 1900. The youngest was thirteen months old, while the oldest was sixty-two years. Six occurred in children fron one to five years of age, 7 from five to ten years, 8 from ten to fifteen years, 56 cases, or 57.1 per cent. of the whole number, between the ages of fifteen and thirty years. There were 13 cases between thirty and forty and but 8 cases over forty years of age. In view of the fact that a relatively small number of children enter the Massachusetts General Hospital, the proportion of cases among children in the series reported by him is perhaps smaller than usual.

Tuberculous peritonitis is usually conceded to exist with greater frequency among females, although some observers maintain that it is more common in the male sex. It would be reasonable to suppose that the statistics should favor the preponderance of the condition among females, on account of their special predisposition to infection through the genital tract. This conclusion seems to be borne out by the obser-

vations of surgeons, which, of course, are based upon purely operative cases.

There are several ways in which the peritoneum is known to become infected. A common method of invasion is from a tuberculous involvement of the wall of the stomach, or of the small intestine, appendix, or colon. The extension of the tuberculous process into the peritoneum from slowly ulcerating deposits upon the intestinal wall in some cases gives rise to purely local changes. In the event of sudden perforation of the tuberculous ulcer a septic general peritonitis rapidly develops through the entrance into the free cavity of the agents of decomposition. The infected area is sometimes sharply circumscribed by the existence of firm adhesions between different coils of intestine. In some instances these adhesions involve the parietal peritoneum.

Another route of infection is that resulting from the caseation and subsequent perforation of mesenteric or retroperitoneal lymph-glands. In such instances the tuberculous process may become diffused throughout the free peritoneal cavity, or it may be localized through the formation of adhesions. An acute septic peritonitis is far less likely to result from this form of infection than from tuberculous intestinal ulcers.

The mesenteric glands have been shown to become infected by the migration of tubercle bacilli through a healthy intestinal wall, an intact mucous membrane constituting no proof that it may not be an atrium of infection. As stated previously with reference to the tonsil, the tissue at the point of invasion may be less favorable for the growth and development of tubercle than more distal parts.

It has not been demonstrated as yet that the peritoneum may become primarily infected by the passage of bacilli through a normal mucous membrane without first producing an involvement of the mesenteric and retroperitoneal glands. The fact that tuberculous peritonitis in exceptional instances has been found to exist in the absence of a discoverable primary focus does not controvert a belief in the secondary nature of the infection.

Another pathway of peritoneal infection is by way of the lymphatics from the pleura through the diaphragm, from the abdominal or pelvic organs or from some distant focus.

The especial frequency of peritoneal tuberculosis in adult females is explained in part by the facilities for direct extension from the female genital organs. The Fallopian tube is frequently a primary focus of infection, from which point the bacilli may gain entrance to the peritoneum, either by direct extension through a free tubal opening or by means of the lymph-channels. It is the consensus of opinion of many observers that the Fallopian tubes are involved in a large proportion of cases of tuberculous peritonitis, which is variously estimated at from 25 to 50 per cent. There seems to be some difference of belief as to whether the involvement of the tube is in general the cause or the result of the peritoneal infection. It is scarcely necessary at this time to review the controversial literature bearing upon the precise direction of the bacillary invasion, whether ascending from the genitals or descending from the peritoneum. It is sufficient to state that the authentic observations of many authorities appear somewhat conflicting and contradictory. Whatever one's theories may be in this matter, it is possible to secure both corroborative and negative testimony as to their correctness. Mayo has called attention to the fact that the tuberculous process in the peritoneum

is especially pronounced in the immediate neighborhood of the primary focus of infection. Certain it is that, irrespective of the source of infection, removal of the tubes is followed in a large number of cases by gratifying improvement. It is also true that in many cases, despite pronounced tuberculous involvement of the tubes, the uterus is found to present an entirely normal appearance. Tuberculous peritonitis has been reported to occur along the route of the male generative tract, although this route of invasion is decidedly less direct than in females. Horowitz describes the pathway from the epididymis through the lymphatics of the spermatic plexus and the ampulla end of the vas deferens. Osler cites seven instances in which the sac alone is involved.

Cruveilhier and Haegler have reported cases of primary hernial tuberculosis. Cotte reports 5 cases of apparently primary tuberculous processes in hernia, together with a summary of 136 recorded cases. It is, of course, easy to understand how hernia may take place in subjects afflicted with tuberculosis of the peritoneum with associated infection of the sac, or of the intestinal coils therein contained, but it is hard to comprehend why there should exist any inherent susceptibility to hernial tuberculosis independent of the peritoneum itself.

Symptoms.—The symptoms of tuberculous peritonitis are somewhat variable, according to the type of peritoneal involvement. The condition is of acute onset in but a small proportion of cases. Shattuck reports 29 of acute onset out of a total of 98. Personally, I have seen but 3 cases of acute tuberculous peritonitis, exclusive of the localized infections coëxistent with a tuberculous appendix. In the latter event the onset is often sudden, presenting rapidly fulminating symptoms. Several of my pulmonary invalids have exhibited tuberculous appendicitis with a localized peritoneal invasion of subacute type.

In the majority of instances tuberculous peritonitis is of slow, gradual development. While the course of the disease usually conforms to the chronic type, there may occur for a time acute exacerbations, periods of improvement being followed by recurring relapses. I recall several cases of remarkably slow and insidious onset, which, after the lapse of several years, exhibited periods of severe pain with other acute manifestations which gradually subsided, but were followed by intervals of abdominal discomfort.

Acute cases of tuberculous peritonitis are always characterized by rather extreme pain, and usually by tenderness and tympanites. The pain, however, is not always of an acute character, and in some cases is but little more than a sense of abdominal discomfort, with occasional intercurring colicky attacks. It is increased by intra-abdominal pressure, the tension upon the abdominal wall often being sufficient to produce a voluntary flexion of the thighs upon the abdomen. This position is suggestive of acute general peritonitis.

Nausea and vomiting are quite common in the acute type, but are rarely present in the chronic form, in which the symptoms are rather vague and ill defined. The severity of such acute symptoms as pain, distention, tenderness, nausea, and vomiting, with weak and rapid pulse, is largely dependent upon the extent of peritoneal involvement. In the event of a general peritonitis these symptoms rapidly develop, and are attended by great prostration and followed shortly by a speedy fatal termination.

In circumscribed tuberculous peritonitis the symptoms are consider-

ably less severe. Both the pain and tenderness are localized, while the vomiting is less frequent and sometimes of but short duration. The fever may be quite as high as in general peritonitis, but the cases run a much longer course, sometimes ending in apparent recovery after a prolonged convalescence.

The **physical examination,** exclusive of the determination of tenderness or rigidity, relates to the detection of fluid and the recognition of definitely circumscribed masses. In cases characterized by excessive exudation, dulness is obtained upon percussion. This is early recognized in the flanks, and is found to vary in location with a corresponding change in the position of the patient. As the fluid increases the dulness in some cases becomes general and fluctuation is detected. Rising of the diaphragm, acceleration of the respiration, and alteration in the position of the cardiac apex is possible in severe cases.

Circumscribed collections of fluid are recognized by palpation, chiefly in the form of rounded, fluctuating tumors. Sometimes, however, on account of the extreme tension of the contained fluid they appear as resisting masses. Hard, unyielding tumors may be present, which strongly simulate solid neoplasms of various organs. These masses, either solid or apparently so, may occur in almost any portion of the abdominal cavity and resemble almost any conceivable new-growth. They may occur in the right or left epigastric region, in either hypochondrium, above the pubis, in the right or left iliac fossa, and in the neighborhood of the umbilicus. The location of the induration and the simulation of solid growth are often sufficient to confound the most experienced examiner. It is possible at times to appreciate a distinct peritoneal friction or crepitation, which affords quite definite information as to the character of the involvement.

Diagnosis.—The diagnosis may be comparatively simple in many cases, but in others it is often exceedingly difficult. Acute perforative cases exhibiting a sudden and violent onset are seldom regarded in the beginning as instances of tuberculous peritonitis. Such cases are likely to be confused with appendicitis, strangulated hernia, and the common form of acute peritonitis, a positive diagnosis often not being established until the abdominal cavity has been opened. In internal hernia and acute intestinal obstruction from other cause the pain, as a rule, is localized and paroxysmal. In such cases the abdominal distention is due to gas rather than to fluid, and constipation is common. The early vomiting soon becomes fecal in character. In appendicitis the onset is usually acute, but the rigidity, pain, and tenderness are localized in a definite area in the immediate region of the appendix. While tumor-like masses are often present in tuberculous peritonitis, they are exceedingly rare in the acute fulminating type, exhibiting a violent onset. In some cases of appendicitis despite the history of chill, rapid pulse, and vomiting, there may be elicited by physical examination not the slightest external evidence of its presence. *Per contra* there may be found a sharply localized area of resistance and tenderness over the region of the appendix, without associated subjective symptoms. This will be considered more fully in connection with tuberculosis of the appendix and simple appendicitis among pulmonary invalids.

Difficulties of diagnosis also attend the chronic forms of general tuberculous peritonitis. In these cases the condition at times may be essentially latent, and give rise to no symptoms whatever. The diagno-

sis is often made at the time of an operation for some other condition among individuals in excellent nutrition. There may be absence of fever or of previous suspicion of tuberculous involvement. Peritoneal infection is undoubtedly present more frequently among pulmonary invalids than is commonly supposed. Many consumptives with quiescent pulmonary infection, display abdominal tenderness, moderate distention, and continuous slight elevations of temperature without explainable cause other than the hypothesis of a mild peritoneal infection. This group of symptoms in the presence of a known tuberculous lesion in the lung capable of producing temperature elevation, is often attributed to disturbances of digestion. Many of these cases exhibit recurring attacks of slight colicky pain, which is more or less vague and indefinite in localization. The persistence of such manifestations among consumptives is sufficient to suggest the possible existence of a chronic peritoneal tuberculosis. Especial confusion is likely to be experienced in the differentiation of the circumscribed exudations and tumor-like masses from the solid neoplasms or fluctuating tumors peculiar to certain organs.

It is hardly appropriate to infringe upon the domain of surgery and enter upon a necessarily detailed consideration of technical diagnostic features pertaining to the simulation of cysts of the pancreas, pyonephrosis, empyema of the gall-bladder, hydatid cysts, ovarian tumors, pus-tubes, pelvic disease, and new-growths in the stomach or intestine. A precise diagnosis is often out of the question without an exploratory operation. A tuberculous omental tumor, however, presents somewhat fewer difficulties than the more definitely circumscribed masses, because of its characteristic elongated shape. When the omentum is the seat of tuberculous infection, it is sometimes stretched across the abdomen in a firm mass which is attached to the transverse colon a little above the region of the umbilicus. This hard, band-like mass may be similarly situated in cases of carcinoma, though less often than in tuberculous processes.

In doubtful cases the existence of tuberculosis elsewhere should afford a reasonable assumption as to the nature of a local peritoneal involvement. In the event of an undiscoverable tuberculous focus in other parts of the body a distinct family history of this disease is of undoubted significance, as is also the admission of an idiopathic pleurisy, glandular enlargements, or caries of bone. It has been shown quite conclusively that the tuberculin reaction in obscure cases is of unmistakable value. If this is absent, a reasonable doubt may be entertained as to the tuberculous nature of the affection, while a positive result is strong *prima facie* evidence of such condition. In doubtful cases recourse to the ophthalmotuberculin test is worthy of trial. As indicated previously the age is often an important determining factor.

I have in mind the case of an intimate friend, thirty-five years old, of tuberculous family history. He was well nourished and unusually robust, but in the midst of apparent health experienced a severe rigor with sharp pain in the left lower abdomen, followed by vomiting and abrupt elevation of temperature. Upon examination tenderness and resistance were at once detected. Had the physical signs existed upon the right side, instead of the left, the conclusion would have been unavoidable that the condition was acute appendicitis demanding imme-

diate operative interference, and in this connection the possibility of transposition of the viscera was entertained. Drs. Powers and Bagot concurred in the non-advisability of immediate exploratory laparotomy and counseled for the time being a policy of delay. After weeks of recurring pain and nausea, with progressive emaciation and physical debility, following the subsidence of the initial violent symptoms, an exploratory operation disclosed extensive tuberculous involvement of the peritoneum with multiple adhesions of intestinal coils. There had previously been recognized upon examination a firm, hard, linear mass extending from the left iliac fossa upward into the flank for a distance of five to six inches. This mass was found to be due to a localized proliferative and adhesive peritonitis, the fibrous tissue growth being especially marked. The patient survived but a few days following the operation. The acute onset of abdominal symptoms took place less than two weeks following an accident while riding horseback through an almost impenetrable region in the mountains, the horse in falling having pressed upon the abdomen with great force. The thought is, therefore, suggested that the tuberculous involvement may have been of traumatic origin.

Prognosis.—The prognosis of tuberculous peritonitis varies in accordance with the age, the severity of the infection, the extent and character of the involvement, and the general condition of the patient. In young children, particularly if of tuberculous parentage, the outlook is less favorable than in adults. Acute cases of suppurative peritonitis following perforation are almost invariably fatal. Localized tuberculous involvement, even if acute, is not necessarily hopeless, though uniformly of grave significance. Exudative cases possess a much more favorable prognostic import than the adhesive and proliferative forms. Many cases are amenable to cure, as the result of either medical or surgical management. Of Shattuck's 25 cases subjected to medical treatment alone, the mortality was 68 per cent., which is accounted for in part by the fact that in all but 6 of these cases there were present other important complications. Among his 57 cases submitting to surgical operation the mortality was 47.3 per cent. An analysis of Shattuck's report disclosed the fact that the most favorable results were obtained in the non-exudative cases, while the mortality was high in ascitic cases irrespective of the nature of the fluid. These results are at variance with the usual conception of the prognostic import attaching to the exudative type as compared with cases exhibiting well-defined masses. As a rule, the subacute or chronic exudative forms furnish the best results, particularly if subjected to operative interference. Modern opinion regarding the manner in which improvement is secured in such cases as a result of opening the abdomen, inclines toward an increased phagocyting power of the white blood-cells by virtue of the direct entrance of air into the abdominal cavity, or, in accordance with the theory of Wright, the presence of a new exudate rich in opsonins. Cameron calls attention to the highly favorable influence resulting from the stimulation given to the lymphatic and vascular circulations on account of the trauma and the reduced intra-abdominal pressure.

It is apparent that operation offers but little to patients exhibiting the fibrous obliterative type or ulcerous form. The existence of advanced tuberculous infection in other parts of the body adds to the gravity of the prognosis. The same is true of suppurative processes, persisting fever, diarrhea, and progressive loss of weight. Generally

speaking, about 50 per cent. of all cases may reasonably be expected to improve, if not absolutely recover.

Treatment.—There is no general method of treatment for tuberculous peritonitis which may be considered justly applicable to all cases. Quite a proportion are known to recover under purely medical management, while some do well after tapping the abdomen and removing as much as possible of the ascitic fluid. Others demand, on the merits of the case, an exploratory operation, which determines at once the nature of the subsequent management. At such a time many cases are discovered to be entirely inoperable.

The general medical treatment is chiefly that of superalimentation, with due regard for possible digestive disturbances, rest, hygienic surroundings, and attention to special symptoms. A suitable environment with cheerful surroundings, good food, and outdoor facilities is of prime importance. Symptoms should be relieved, if possible, as they arise. It is proper to resort to occasional tapping if demanded for the comfort of the patient. My experience with this condition has been somewhat limited, but sufficient to afford satisfying proof as to the efficacy of rest, improved nutrition, and absence of worry in the effort to establish convalescence. I have in mind a young lady in whom the diagnosis of peritoneal tuberculosis was established at the time of operation for appendicitis in 1900, previous to which there had been no symptoms suggestive of abdominal disease. For several years following the operation there were no clinical evidences of peritoneal infection, but there developed a slight pulmonary involvement with laryngeal complications which constituted the basis for her coming to Colorado. In the midst of a most excellent nutrition, absence of cough, expectoration, and fever, there took place, five years following her initial peritoneal involvement, a severe rigor and sharp elevation of temperature, associated with intense abdominal pain and vomiting. Examination of the abdomen was entirely negative, save for a very slight distention and general stiffening of the abdominal wall, without localized tenderness. With recurring chills and continued high elevation of temperature, increasing abdominal distention, and beginning general tenderness, the abdomen was opened by Dr. Powers, and an extensive adhesive tuberculous peritonitis was found. The serous membrane was studded throughout both its parietal and visceral layers with small tubercle deposits, and there were multiple adhesions between the intestinal coils, adjacent organs, and the abdominal wall. The case is of especial interest in view of the knowledge that during a period of many years, despite an extensive pathologic change involving the wall of the peritoneal cavity and its contents, she exhibited no symptoms whatever of general or abdominal disturbance. The operation was indicated as an exploratory procedure, but was recognized to be unavailing as a therapeutic measure, on account of the character and extent of peritoneal infection.

It is often difficult to determine satisfactorily when the indications point conclusively toward the expediency of operative interference. An exploratory laparotomy is often justified after failure to secure improvement under four to six weeks' medical management, and earlier if the patient is rapidly declining.

In acute miliary tuberculosis the patient often dies before the symptoms of peritoneal infection are apparent, but if detected, operation is clearly contraindicated in the majority of cases. All cases presenting

evidence of acute intestinal obstruction should be accorded the possible benefit to be derived from abdominal section, although unusual difficulties for successful results are presented by the existence of the numerous adhesions.

Surgical interference avails practically nothing in cases associated with great prostration and emaciation. The coëxistence of tuberculous infection in other parts of the body does not necessarily contraindicate operation, providing the general condition is not that of extreme prostration. The nature of the operative interference must vary in individual cases. A simple incision is sometlmes sufficient and often highly satisfactory. The opening of the abdominal cavity must be performed with special care, on account of the possibility of intestinal and peritoneal adhesions immediately beneath the site of the incision. It is important to remove as much of the contained fluid as possible in order to diminish the likelihood of reaccumulation. It is rarely advisable to resort to drainage or flushing of the abdominal cavity. In general, the less meddlesome the interference, the more satisfactory the results. It is unwise to attempt to break up adhesions unless to relieve intestinal obstruction or to provide opportunity for the removal of the contained fluid.

It is important to remove, when possible, local foci of infection. This applies particularly to the Fallopian tubes, the appendix, or large cheesy masses in the omentum. It is under such circumstances that drainage is at all permissible, and even then but for a short period. The danger of fecal fistula is much enhanced in those cases in which drainage is employed.

A reaccumulation of fluid does not in itself contraindicate the performance of a second or a third operation.

SECTION IV

GLANDULAR TUBERCULOSIS

CHAPTER LIX

PATHOGENESIS OF GLANDULAR INFECTION

THE relation of the **lymphatic system** to the development and spread of tuberculosis is of exceeding interest. The distribution of bacilli from a primary focus of infection is effected in very many instances along the lymphatic and circulatory channels. In the light of comparatively recent investigation it is known that tuberculosis of the lymph-nodes, *i. e.*, the cervical, tracheobronchial, mesenteric, and retroperitoneal glands, often represent primary foci of infection. An initial tubercle deposit having taken place, the infection is conveyed subsequently by way of the lymphatics much more frequently than by the blood-vessels. When the vascular system is the sole carrier of bacilli, the

infection of various tissues is found to occur in distal portions of the body in sharp contrast to the direct sequence of glandular involvement which ensues when the microörganisms are distributed through the lymphatic channels. In the latter instance the proximal gland is the first enlarged, the subsequent infection throughout the immediate chain of lymphatics exhibiting a progressively diminishing centrifugal involvement. The smaller size of the glands in proportion to their distance from the original infective focus illustrates the method of gradual bacillary invasion along the lymphatic route. When the filtrative capacity of the successive glands has become completely overtaxed, the barriers are removed, which hitherto have obstructed to a degree the onward march of the invaders. The progressive advance of the infection is shown not only by the gradually diminishing size of the glands, but as well by the serial stages of the tuberculous process. In the presence of an overpowering invasion of bacilli the proximal glands in their effort to perform their defensive function may be so overwhelmed as to result in tissue destruction. Local degenerative processes take place. The infected gland may contain caseous foci of various sizes, or become transformed into an abscess containing sterile pus. In other glands less proximal to the original site of infection the battle is not always so completely in favor of the invaders. The bacilli may be held as prisoners and rendered incapable of doing further damage until their release is secured by sufficient reinforcement to overpower the tissue-cells constituting the army of defense. In more distal glands the enlargement may be so slight as to differ but little from the normal size, and yet a minute tuberculous focus may be present either in the interior or upon the surface. It has been shown that not only are the bacilli in many cases held in comparative security within the confines of the besieged glandular citadel, but often are rendered more or less innocuous.

Osler has referred to the experiments of Arloing as indicating a degree of degeneration of the tuberculous virus. Rabbits did not succumb to inoculation from a lymphatic gland, although a positive result was obtained with guinea-pigs. Lingard demonstrated a quick lymphatic infection and early death upon inoculation of guinea-pigs with tubercle bacilli from the lungs, as compared with a delayed lymphatic enlargement and death when infected from scrofulous glands.

It is known that bacilli from glandular structures are considerably less virulent than those from almost any other tuberculous focus in the body. Whether this is due to a difference in the infective material or to certain modifying influences of the lymphatic glands has not as yet been determined.

Irrespective of the distance of the gland from the original site of infection, there occasionally ensues such a degree of fibrous tissue proliferation as to produce a complete protective metamorphosis, the capsule becoming enormously thickened and the septa being tough and fibrous. In other cases a true calcification may result from the abundant deposit of lime salts. Induration of the glands with increasing fibroid contraction is sometimes stimulated by the presence of mineral dust. This is, of course, particularly true of the tracheobronchial glands, which become densely pigmented and even gritty from the inhalation of particles of palpable dust.

In view of the involvement of glands nearest to the port of entry of infective material, it has followed that given *glandular systems are found*

to drain certain tributary areas. Thus the glands of the neck, including the auricular, cervical, submaxillary, and even the supraclavicular and infraclavicular, constitute the lymphatic filters of the nose, throat, tonsils, palate, mouth, ears, and orbit, as well as the skin of the face or head. There are both superficial and deep glands of the neck. The latter constitute a chain extending from the skull to the thorax, along the sheath of the carotid and jugular, establishing a communication with the thoracic and axillary glands, as well as with the corresponding set of the opposite side. The deeper group especially serves as a reservoir for the lymphatics of the tonsils, mouth, nose, eye, and larynx. Glandular enlargement is usually noted in the region of the angle of the jaw before a downward extension along the neck is recognized.

In like manner the tracheobronchial glands are the reservoir for the lymphatics from the lungs, pleura, and surrounding parts. These glands are located near the bifurcation of the trachea, and are more numerous, as a rule, upon the right than upon the left side. A chain of smaller glands lie in close proximity to the left recurrent laryngeal nerve in its course under the aorta, and another along the right in its passage under the subclavicular artery. Glands accompany the smaller lymphatics along the primary divisions of the bronchi, and are found, according to Quain, at the bifurcation of the branches of the pulmonary artery. There is some difference of opinion regarding the intercommunicability of the lymphatics of the neck and chest. Barety is quoted by Dr. J. N. Hall as authority for a relationship between the bronchial and supraclavicular glands, upon the basis of a connecting link established by a group of glands behind the sternoclavicular articulation. Volland ascribes the origin of many cases of pulmonary tuberculosis to an infected cervical gland. Cornet calls attention to the fact that while involvement of the cervical glands may occasionally take place by extension upward from the bronchial glands, nevertheless, in pulmonary tuberculosis of children, the glands of the neck are rarely diseased. In case of a simultaneous involvement of the cervical and bronchial glands he chooses to assume a separate focus of infection for the two groups.

The mesenteric or retroperitoneal glands serve as filters for the intestinal tract, the peritoneum, and sometimes the genito-urinary apparatus. Less interest attaches to tuberculosis of lymphatic glands of other parts of the body on account of the comparatively slight opportunity of infection through the skin.

In defining certain sets of glands as the drainage basin for a given tributary area, it must not be assumed that a primary focus of tuberculosis necessarily exists within this region. As a matter of fact, the majority of cases of glandular tuberculosis, especially in children, are of primary rather than secondary development, as has been clearly established through the recognition of a macroscopically intact mucous membrane.

Ravenel has shown by experiments upon dogs that the bacilli may pass through an intact intestinal wall directly to the mesenteric lymphatic glands. Sydney Martin has also demonstrated that the bacilli may permeate a healthy intestinal mucosa and gain access to the mesenteric glands. Cornet, Orth, Klebs, Baumgarten, Walsham, and Litterer, as well as Calmette and his followers, have concluded, as the results of their own experiments, that the tubercle bacillus often secures a port of entry through a normal mucous membrane. Benda and Hamilton

voice the consensus of opinion that the point of invasion, by virtue of local conditions, may be an unfavorable site for tuberculous development, and yet the bacilli be conveyed to a soil which is more receptive. It is known that tuberculous glands are found with great frequency at autopsy among children in whom there are no other discoverable lesions.

Repeated investigations have demonstrated the **rôle of the tonsils and adenoid vegetations** in affording a port of entry for the tubercle bacillus, even in the absence of local inflammatory changes. The deep crypts in the tonsillar tissues constitute an infection atrium from which the further progress of the bacilli along the lymphatic channels to neighboring glands is practically unimpeded. On the other hand, tubercle bacilli have been shown to be present in the tonsils and in adenoid growths despite failure to discover tuberculous infection in other parts of the body. The adenoids have been found tuberculous somewhat more frequently than the tonsils, undoubtedly on account of the greater narrowing of the respiratory passage and the increased opportunities afforded for tubercle deposit.

Fifteen per cent. of all adenoids were found tuberculous by Lartigau, while Robertson reports but 8 per cent. of hypertrophied tonsils to be infected. Lermoyez, as a result of inoculation experiments upon guinea-pigs, stated the proportion of tuberculosis in adenoids to be 20 per cent. and in hypertrophied tonsils 13 per cent. Wood reports that out of a total of 1671 adenoids or tonsils examined for tuberculosis, without evidence of tuberculous involvement elsewhere, a positive result was obtained in 88, or about 5 per cent. The presence of tubercle bacilli in the tonsils and adenoid growths of apparently healthy individuals suggests the probability of their not infrequent passage to the lymphatic glands, producing therein a primary seat of tuberculous infection. Jacobi has held to the opinion for years that infection of the cervical nodes occurs much less frequently through the tonsils or adenoids than through the medium of the lymph-follicles in the nose and pharynx. It must be admitted that enlargement of the cervical lymph-glands follows inflammatory processes in the nose and nasopharynx more quickly and more frequently than an infection confined solely to the tonsils.

It has been shown conclusively that when the lungs are also diseased, the pulmonary involvement in the vast majority of cases is secondary to tuberculosis of the bronchial glands.

The precise manner in which the bronchial glands become subject to tuberculous infection remains a somewhat disputed point, although the preponderance of evidence suggests an invasion of the body by bacilli through the digestive system. Some maintain that the essential consideration is the aspiration of the bacilli into the bronchial tract and their passage through an intact bronchial mucosa. Behring asserts that the infection takes place originally through the intestine rather than by inspired air. He believes the infant's milk to be the chief source of tuberculosis in childhood as well as in adult life. He asserts that the foci of infection thus engendered remain latent for varying periods of time until individual resistance is sufficiently lowered to permit their active development. Behring's views have been discussed in connection with the method of infection through the alimentary canal, as have also the experimental observations of others who have demonstrated the ease with which tubercle bacilli may penetrate the

intestinal wall without visible lesion and gain ready access to the glandular structures. The later researches of Calmette and Guerin, Engel and Schlossman, have shown the passage of bacilli through an intact mucous membrane to the mesenteric and bronchial glands of animals, and their early appearance in the thoracic duct and pulmonary artery. Behring's contention that the permeability of the intestinal wall is much greater in infancy on account of the more delicate structure is of much interest. Differences in the passage of microörganisms through the wall of the intestine at varous ages were demonstrated by experiments upon animals. Tubercle bacilli were fed to guinea-pigs with the result that only the very young became tuberculous, enlargement of the glands of the neck being noticed even while the general condition appeared entirely normal. Ravenel, on the other hand, has recently introduced tubercle bacilli with the food into the stomach of two monkeys and one cow, producing tuberculosis of the bronchial glands and lungs without mesenteric or intestinal lesions. Some investigators have been unable to produce tuberculosis of the lungs or bronchial glands after carefully conducted inhalation experiments. There can be no doubt as to the primary involvement of the bronchial lymphatic nodes in little children. In the light of all the evidence presented it would seem that it must remain *sub judice* whether in *individual* cases the initial infection is purely respiratory or intestinal. It has been demonstrated beyond question that the infection may pursue either of these routes in different cases.

Apropos of experimental investigation, it may be stated that the important consideration in *this connection* is not altogether the determination of the exact pathogenesis of glandular infection, but rather the fact that, by whatever route, glandular tuberculosis occurs with great frequency in little children.

Opinions differ concerning the significance of the family history. Statistics have been cited both to demonstrate and to deny the influence of heredity as an etiologic factor. Lowered resistance may take place among children of healthy parents, while others with more or less inherent predisposition to disease may thrive by virtue of especially favorable conditions. A positive family history of tuberculosis while not to be regarded as a factor of great import, must, nevertheless, be conceded to possess some practical significance. The reasons for a greater frequency of glandular tuberculosis in children than in adults are found in the comparative ease with which the delicate mucous membranes are traversed by bacilli, and the increased facilities with which the germs are conveyed through the open permeable lymph-spaces. In addition may be cited certain accessory features which increase the likelihood of infection and to a material extent diminish individual resistance. The influence of enlarged tonsils and adenoids in encroaching upon the normal respiratory passages and offering a site for the deposit of bacteria has been mentioned. Infants being directly dependent upon the care of others are subjected to increased danger of exposure to tuberculous infection. The child is often upon the floor, and thus is brought in closer contact with the bacilli, which contaminate the carpets and rugs. The vitality of infants is frequently reduced by digestive disorders and catarrhal disturbances, inferior ventilation, and improper hygienic conditions. Irrespective of the causes, the fact remains that tuberculosis is exceedingly common in childhood and that,

in the great majority of cases, the lymphatic glands constitute the primary focus of infection. The accuracy of this statement is substantiated by the reports of numerous observers. Medical literature abounds in statistical analyses as to the frequency of tuberculosis of the lymph-nodes in childhood. For the purposes of illustration it is well to refer briefly to some of these investigations, though any attempt to quote at length would seem superfluous.

Volland, Beruti, Balmann, and Wohlgemuth, as the result of an examination of very many children, report the cervical lymphatic glands to be enlarged in the proportion of from 81 per cent. to 96 per cent., according to Pottenger. The reports of other observers as to the character of the cervical enlargement in children would indicate that nearly two-thirds are tuberculous. Cornet's analysis of the autopsy records of the Berlin Pathological Institute for a period of fifteen years shows not a single case of tuberculosis out of 486 cases from birth to the end of the first month; from two to three months, 6 per cent. of the cases; from three to six months, 10.5 per cent.; from six to nine months, 17 per cent.; from nine to twelve months, 27.7 per cent.; from one to two years, 26.6 per cent.; from two to three years, 29.6 per cent.; from three to four years, 31.8 per cent.; from four to five years, 22.4 per cent. Several other observers, notably Müller, Bâbes, Heubner, Newmann, Still, Hand, Simonds, Schever, Bolz, Jacobi, and Holt have reported statistics not especially dissimilar to these results, the proportion ranging, in children up to five years, from 22 to 40 per cent. Foreign statistics concerning the prevalence of glandular tuberculosis show higher percentages than are obtained in this country. Nearly all observers agree that, in the majority of cases, the pathologic evidence points to involvement of the lymphatic glands as the primary foci of infection, the lungs being secondarily diseased. In autopsies upon tuberculous children the bronchial glands are almost always found tuberculous.

Cornet quotes the statistics of Steiner and Neureutter, who report tuberculosis of the lymph-glands in 299 out of 302 autopsies. The bronchial glands were tuberculous in 286 of these cases. He also refers to the report of Rilliet and Barthez, who found the lymphatic glands tuberculous in 248 cases out of a total of 312 autopsies upon tuberculous subjects. Northrup's report of bronchial glandular involvement in every instance in a series of 125 autopsies has been widely quoted. The same results were obtained by Northrup in a second series of 125 cases in the New York Foundling Hospital. Holt reports 119 cases in which the bronchial glands were tuberculous in every instance. In 115 autopsies Hand reports the bronchial glands involved in 81.7 per cent.; the lungs, in 78 per cent. Both Steffen and Bulius found the lymphatic glands infected in nearly every autopsy reported upon tuberculous patients. All observers agree that the tracheobronchial glands are involved more frequently than any others, with the cervical system next in order. Haushalter, in a report upon the results of 78 autopsies performed upon children who had died of acute miliary tuberculosis, states that tuberculosis of the mediastinal glands was found in all but 4 cases. Enlarged bronchial glands from individuals exhibiting no evidence of tuberculosis have been found by inoculation experiments to be infective to animals. Allusion has been made to the experiments of Pizzini and others, who reported positive inoculation results in a large proportion of cases.

Pizzini, after inoculating animals with the bronchial glands of 40

patients, found 42 per cent. tuberculous. It is interesting to note that injection of the cervical glands from the same subjects was followed by tuberculosis in but 2 per cent. of the animals, while none showed evidence of infection with inoculation of the mesenteric glands. Loomis has demonstrated by inoculation experiments with bronchial glands the existence of tuberculosis which had previously been unrecognized. Bertalot discovered tuberculosis of the bronchial glands in 20 out of 24 children who had died of tuberculous meningitis. Both Reiner and Henoch report tuberculosis in nearly all cases of tuberculous meningeal infection.

The symptomatic manifestations of enlarged tuberculous glands vary according to their location. The clinical picture of cervical tuberculous adenitis is quite different from that of tabes mesenterica. Enlargement of bronchial glands often produces still another characteristic grouping of symptoms, as well as definite physical signs. It is well, therefore, to consider separately the clinical features of tuberculosis of the various lymph-nodes.

CHAPTER LX

TUBERCULOSIS OF THE CERVICAL GLANDS

This form is very common among little children, and not infrequently occurs in young adults. It exists occasionally in middle life. Local conditions favoring its development are hypertrophied tonsils, chronic catarrhal processes in the nose, nasopharynx, and pharynx, eczema of the scalp, otitis media, and disease of the gums or teeth. Tuberculous glands of the neck often accompany a beginning convalescence from measles, whooping-cough, and sometimes influenza. During the past few years I have noted an increasing number of instances of enlarged glands near the angle of the jaw in children following influenza and simple tonsillitis. Many of these cases were at first regarded as belonging to the category of ordinary glandular fever, but their chronicity suggests the probability of a tuberculous infection.

Among general conditions predisposing to the development of tuberculosis of the cervical glands may be mentioned insufficient ventilation, improper and deficient food, poor surroundings, and inadequate clothing. An important factor is the reduced vitality incident to disturbances of digestion and nutrition.

Tuberculous cervical adenitis may be unilateral or bilateral, although in the latter event the process is usually more pronounced upon one side. An essential characteristic of the condition is the chronicity of its course. The onset may be insidious to a degree, the attention being first attracted by the accidental discovery of a few small, hard, rounded nodules, which are usually painless and freely movable under the skin. Occasionally, however, the beginning involvement is more abrupt, especially if following an attack of measles, whooping-cough, diphtheria, tonsillitis, scarlet fever, or influenza. Under these circumstances the glandular enlarge-

ment assumes the appearance of a brawny, diffused inflammatory mass, which is often tender and adherent to subjacent structures.

Cases with insidious onset may sometimes persist for years without the knowledge of the patient or parents, the enlargement being imperceptible upon ordinary inspection, but easily recognized upon palpation.

The submaxillary group of glands are more frequently involved, but it is very common to detect a chain of small nodules extending along the anterior or the posterior border of the sternocleidomastoid muscle. Tuberculous cervical glands occur more often in the upper portion of the neck than at the base, in contradistinction to the glandular enlargement of Hodgkin's disease. It does happen occasionally, however, that the glands above the clavicle and in the posterior cervical triangle become tuberculous in connection with a similar involvement of the axillary glands.

In the insidious form of cervical adenitis the diseased glands are isolated, firm, smooth, globular or ovoid in outline, devoid of pain, and more or less movable under the skin. In the acute cases the glands are more swollen, often irregular in shape, and even if painless and hard, are, as a rule, less movable. They frequently become fixed to the surrounding parts, though the skin is not always adherent. As the inflammation increases still more the glands appear to be somewhat fused, forming a large, brawny or knotted swelling which is sometimes distinctly painful and tender. As suppuration takes place the swelling increases, fluctuation is detected, the skin becomes fixed to the mass, and localized bulging and redness develop. The skin is often very thin over the area of suppuration.

Cases attended by abscess formation usually exhibit elevation of temperature, although fever is by no means constant. It is often present despite the absence of pus, particularly when the glands are of large size. The patients are usually anemic and poorly nourished. The scrofulous type of face has frequently been described as consisting of thick lips, coarse features, broad nose, muddy complexion, and generally heavy aspect.

The course of the disease is slow and unsatisfactory in a large number of cases, but a fatal termination rarely supervenes. Meningeal extension is much less frequent than from tuberculosis of the bronchial glands. That general miliary involvement is not more common is somewhat difficult to explain. Although tuberculous glands of the neck may persist for years in individuals perfectly well in other respects, the fact remains that they constitute an ever possible source of infection. The constant menace to life resulting from the presence of insignificant and apparently harmless nodules in the neck is illustrated by the following case. I have recently seen a young man with general miliary tuberculosis, the origin of which is undoubtedly to be traced to a small gland in the neck the size of a small walnut, of one and one-half years' duration. On account of the general invasion, with characteristic acute laryngeal involvement, the patient has been advised to return to his home. Fig. 111, reproduced from a photograph, shows not only the small size of the gland, which is almost unnoticeable unless the head is inclined to the opposite side, but also the excellent nutrition, which thus far has been but little affected.

Diagnosis.—The special feature of diagnosis, aside from the existence of tuberculosis elsewhere, relates to a differentiation from the

enlargement of simple inflammatory adenitis, lymphatic leukemia, and Hodgkin's disease.

The persistence of the mass without acute inflammatory signs, particularly in the absence of such exciting causes as the acute infectious diseases or poor teeth, sufficiently characterizes the condition to exclude a simple glandular abscess.

The absence of leukocytosis, which always accompanies lymphatic leukemia, is easily determined by the examination of the blood. It is sometimes difficult to differentiate accurately between lymphatic tuberculosis and the lymphadenoma of Hodgkin's disease. In general it may be stated that in the latter condition suppuration rarely takes place, and the glands are usually firmer, harder, and less tender than in tuberculosis. Although they may attain large size, they are more often discrete and less adherent to one another and to surrounding parts.

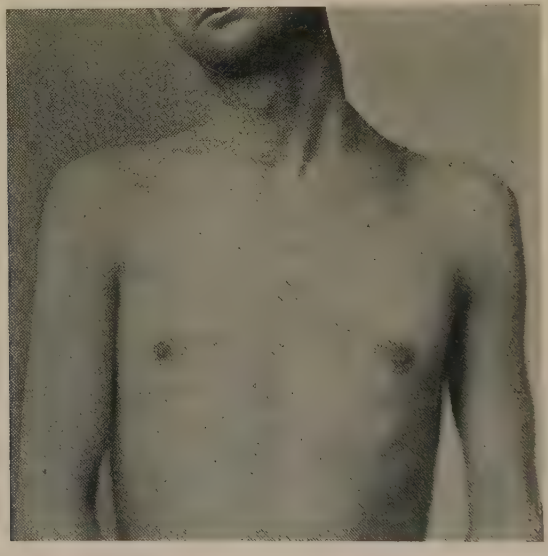


Fig. 111.—Showing very small tuberculous gland upon the left side of the neck of one and one-half years' duration, followed by recent development of miliary tuberculosis.

They rarely are fused into large masses, but tend rather to preserve their individuality, and, as a rule, are somewhat movable under the skin. The condition is perhaps less frequent in children, although it may occur at any age. In Hodgkin's disease the site of the enlargement is usually in the lower part of the neck, while the reverse is true in tuberculosis. The tuberculin reaction is not always perfectly reliable, as it has been shown that the two conditions may coëxist. Fever may be present in either case. It is probable that the ophthalmotuberculin test may be of value when the diagnosis is obscure. Several cases have been reported presenting the clinical picture of Hodgkin's disease, which were found to be tuberculous at autopsy. Sternberg and Musser are quoted by James as of the opinion that the glandular enlargement of Hodgkin's disease is tuberculous in character, thus explaining the irregular fever which so often is present. Dr. D. M. Reed and Dr. W. B. James, however, report negative results from inoculation experiments and careful study of the

glands in a number of cases of Hodgkin's disease exhibiting temperature elevation.

The difficulties of exact differential diagnosis between the two conditions is shown by a case which has been under my observation something over ten years. The patient was thirty years old, of negative family history, and previous good health when he consulted me with reference to a rapidly growing mass in the left neck, slightly above the clavicle. The enlargement had been of but three or four weeks' duration, but was associated with much general weakness, extreme pallor, and emaciation. The glands were hard, perfectly discrete, painless, and more or less movable, presenting no resemblance to a brawny swelling. There was no redness, adhesion of the skin, or fever. The injection of tuberculin for diagnostic purposes was attended by a negative result. The glands continued to increase in size until the patient was unable to wear a collar. A second group of glands became

Fig. 112.—Illustrating the pronounced diminution of cervical glandular enlargement which had previously persisted during a period of ten years. (See text. Compare with radiograph, Fig. 48, p. 255.)

enlarged back of the angle of the jaw, and presented the same characteristics. There developed a slight involvement upon the right side of the neck, in the left axilla, and in each groin. The spleen became distinctly palpable. The examination of the blood was negative. The patient rapidly became prostrated and was forced to remain in bed. The diagnosis of Hodgkin's disease was made and later indorsed unequivocally by Drs. Bergtold, Powers, Whitney, and others. The family were informed as to the hopeless nature of the condition and a comparatively speedy termination was expected. There soon developed an intense bronzing of the skin of the entire body, with progressive glandular enlargement. Almost daily vomiting prevented recourse to superalimentation. The treatment consisted simply of rest, very large doses of Fowler's solution, and bone-marrow. The downward progress of the disease gradually became arrested, but the patient remained in bed for a period of many months, followed by a life of invalidism for nearly two years. The glands became slowly and almost imper-

ceptibly reduced in size, as also the spleen. The bronzing of the integument persisted for three or four years and was accompanied by a remarkable thickening of the skin of the hands and feet, with pronounced peeling at short intervals. Two years after the initial onset the patient was seen by Dr. Coley, of New York, who concurred in the previous diagnosis. During the ensuing years several relapses of a milder nature have taken place. Since the introduction of the *x*-rays their employment has been resorted to periodically in this case with considerable benefit. At the present time the patient exhibits all the external appearances of perfect health, and the enlarged glands of the neck have almost entirely disappeared. There remain two nodules of moderate size, recognized upon inspection, in the upper left neck, and several small palpable masses in the lower right, just above the clavicle. There is, moreover, dulness with diminished intensity of the respiratory sounds at each apex, extending nearly to the second rib. As a result of prolonged *x*-ray exposures a well-defined telangiectasis has appeared upon each side of the neck. Fig. 112 represents the photograph of the neck just taken, which is of interest in connection with the skiagraph, Fig. 48, showing well-marked apical involvement of the lung. In plate 11 is shown the present telangiectatic condition upon each side, and the two visible nodules upon the left. It would appear that no case could present a clearer picture of Hodgkin's disease, and yet, in the light of the improvement and the present physical signs, despite a negative tuberculin test, the conclusion is forced that the original glandular infection was of a tuberculous nature.

CHAPTER LXI

TUBERCULOSIS OF THE MEDIASTINAL AND MESENTERIC GLANDS

MEDIASTINAL GLANDS

The clinical manifestations of tuberculous enlargement of the tracheobronchial glands are extremely varied in character, there being no direct relation between the symptoms and physical signs. It frequently happens that pronounced symptoms arise suggesting the probability of enlarged mediastinal glands, with an entire absence of objective signs. In other cases the physical evidences of tuberculous glandular enlargement may be so definite as to permit the recognition of a distinct mass without the exhibition of symptoms. The condition is more common in little children than at any other age; typical cases in young adults are not infrequent.

Both the symptoms and signs are largely dependent upon the *location* of the glandular enlargement, the *degree of compression* exerted upon contiguous parts, with consequent *functional* disturbance, the *possible perforation* through an intervening wall into adjacent structures, and the *extension* of the *infection* through the lymphatics into neighboring tissues.

Fig. 1.—Present telangiectatic condition right side of neck, following prolonged use of *x*-rays for tuberculous cervical glands.

Fig. 2.—Same patient as preceding. Diffuse telangiectases left side of neck, following *x*-ray therapy.

The usual location of the tuberculous glands has been stated to be in the neighborhood of the bifurcation of the trachea in the posterior portion of the mediastinal space. Attention has been called to their frequent proximity to the left recurrent laryngeal nerve. Among neighboring structures apart from the trachea and bronchi are the pulmonary artery, the superior vena cava, the aorta with its branches, the pulmonary veins, the pneumogastric and phrenic nerves, and the esophagus. Well-defined symptoms may result from compression of any of these parts to a greater or less degree by a mass of tuberculous glands. The nature of the symptoms varies according to the particular point of compression upon any of these structures. The pressure symptoms of perhaps more frequent occurrence relate to the trachea and primary bronchi. If compression be exerted upon the trachea alone, alarming dyspnea may supervene. This is often associated with a violent dry paroxysmal cough, not very dissimilar to that of pertussis. In other cases the cough and respiration simulate asthma to some extent. The severity of these symptoms is not altogether dependent upon the degree of compression. I well remember the case of an adult who exhibited most distressing dyspnea, with almost incessant paroxysmal cough and wheezing respiration. There was found at autopsy but slight compression from a glandular mass adherent to the trachea, penetrating the posterior wall and protruding within the lumen to the size of a small pea.

The **physical signs** of **tracheal compression** consist primarily of a diminished respiratory excursion and an enfeebled respiratory murmur in all parts of each lung. Normal resonance is elicited upon percussion. I have never recognized the peculiar character of the respiratory sounds described by the French as *cornage*, which is ascribed to the rush of air through a narrowed lumen, but have noted an inspiratory retraction of the thorax, the so-called *tirage*, which is often pronounced in the lower lateral region. Edema or spasm of the glottis and genuine diphtheria may be excluded by laryngoscopic examination and by the fact that the voice is unaffected in tracheal obstruction.

When the compression is exerted upon *a single primary bronchus*, there is but moderate dyspnea unless the enlargement of the gland has taken place suddenly. As a rule, the increase in the size of the affected glands is gradual and hence the pressure occlusion of the bronchus is incomplete and the dyspnea slight. In such cases there are often no *symptoms* incident to the pressure upon the bronchus *per se*. If subjective clinical manifestations are present, they are occasioned by pressure upon other contiguous parts, as will be explained.

The **physical signs of bronchial compression,** however, are defined sharply and constitute a group of clinical data sufficient to characterize the condition and lead to its almost invariable recognition. Upon inspection the restricted mobility of the affected side is at once apparent. In place of the inspiratory expansion is seen a more or less pronounced retraction in the lateral region. Upon percussion there is found but slight, if any, deviation from the normal resonance. The respiratory sounds are absent altogether, or else markedly diminished in intensity, without perceptible difference in rhythm, pitch, or quality, save for the occasional recognition of the *cornage*. In exceptional instances a capillary bronchitis is detected by the presence of extremely fine moist râles, which are disseminated throughout the lung of the affected side. This

condition is rarely incident to the compression itself, but is produced by the penetration of the gland *en masse* into the bronchus, with subsequent aspiration of tiny particles of infective material, to which condition attention will presently be directed. The presence of a closed pneumothorax may be excluded by the failure to recognize a dislocation of the cardiac apex, together with other signs previously alluded to. The unchanged percussion resonance and diminished breath-sounds then permit an assumption as to the existence of some form of bronchial obstruction. The nature of the obstruction is determined, as a rule, by a review of such essential features as the age, history, habits, and a further study of the physical signs. The suspicion of a foreign body in the bronchus may usually be eliminated by the history. Aneurism is often excluded by the age, history, and associated conditions, together with the absence of signs especially characteristic of the condition. An *x*-ray examination is sometimes of undoubted value in obscure cases.

The compression of other contiguous structures, though somewhat less frequent than that of the trachea or large bronchi, is attended by rather more conspicuous symptoms.

Pressure upon the recurrent laryngeal nerve may produce hoarseness or aphonia, together with a paroxysmal cough, the latter often being extremely distressing. (In this connection it is interesting to note that the chronic noisy breathing of horses, commonly termed "roaring," is occasioned by pressure upon one of the nerves controlling the movements of the larynx by lymphatic glands within the chest.) The cough usually persists indefinitely and is not attended, as a rule, by an inspiratory whoop. There is often no expectoration whatever, but if present, it consists almost entirely of mucus. The laryngoscopic evidences of compression of the recurrent laryngeal are numerous and varied. There may be paralysis of any single muscle, and in some cases of a pair of muscles, as all the movements of the larynx are controlled by the recurrent laryngeal nerves. Complete or partial paralysis of at least one group of muscles is almost always observed. Pressure upon the recurrent laryngeal may produce dyspnea, irrespective of the presence or absence of bronchial compression. Dyspnea is also effected by compression of the phrenic, and often occurs in conjunction with hiccough. Painful and difficult swallowing, as in esophagismus, sometimes results from esophageal obstruction or compression. Dr. J. N. Hall has called attention to the possible development of the traction diverticula in the esophagus from contraction changes either in the gland or in the esophageal wall, giving rise in part to the symptoms of obstruction. He also alludes to the possible effect of pressure upon the pulmonary artery in facilitating the tendency to pulmonary tuberculosis through the lessened blood-supply. In the event of compression of the superior vena cava an impeded venous circulation is noted in the veins of the face, arms, and shoulders, and sometimes over the anterior surface of the thorax. In these cases the network of distended veins is plainly discernible upon the skin. Edema of the lungs may result from compression of the pulmonary veins. Vomiting or tachycardia may be present from compression of the pneumogastric, and either dilatation or contraction of the pupil, as a result of pressure or irritation of the sympathetic.

It should be borne in mind that the pressure symptoms referable to enlarged bronchial glands are occasioned not only by the *contiguity* of important structures, but also by the *immobility and resistance* of the

parts in contrast with the easily movable and yielding walls within the abdominal cavity.

In the event of adhesion to immediate structures, with perforation of an intervening wall, the resulting changes are often of especial importance. The gland may penetrate the bronchus, soften, and permit the aspiration of tiny particles of infective material into the corresponding bronchial tract. The symptoms and physical signs of a bronchiolitis are not infrequently merged into an acute bronchopneumonia. This form of pneumonia of tuberculous origin usually induces an early fatal termination. Abscess of lung and pulmonary gangrene may possibly develop as secondary processes following the perforation of a bronchus.

Many instances are on record relative to the discovery at autopsy of bronchial glands in the air-passages. In many of these cases the gland producing the obstruction was found to be of such size as to prevent its expulsion through the trachea and larynx. It is not altogether impossible that a sloughing gland may be expectorated. Some years ago Hall reported a case of obstruction of the left primary bronchus, which was presumably from a tuberculous gland. This was followed by bronchopneumonia of the adjacent lung, with expectoration of a large amount of pus daily, without evidence of empyema or bronchiectasis. There was an abrupt cessation of the expectoration, with speedy complete recovery after the expectoration of a "fleshy mass, presumably a bronchial gland." Dr. Hall was unable to secure the supposed glandular obstruction for the purpose of examination.

Cases of calcareous metamorphosis of the affected gland have been reported, with the expectoration of so-called lung stones.

When perforation takes place into the trachea, sudden and alarming dyspnea invariably supervenes. Such a condition is the probable cause in many instances of sudden death in little children following abrupt and severe dyspnea. Several cases confirmed by autopsy have been reported. Instances of perforation of the esophagus by an ulcerating gland are fairly numerous, as well as rupture into the pleura and pericardium.

Although glandular perforation is by no means essential for the production of tuberculous pleurisy and pericarditis, these secondary processes, together with pneumothorax and mediastinal abscess, are sometimes the direct result of a suppurating tuberculous gland. Perforation of the wall of the larger blood-vessels is comparatively infrequent, but has been found to take place in the pulmonary artery and the aorta. Ulceration into a vein establishes a direct communication of the softening gland with the blood-current, and results in a miliary tuberculous infection.

Tuberculous meningitis, as well as the other forms of general miliary tuberculosis, are known to be secondary in a large proportion of cases to involvement of the bronchial glands, both the blood- and lymph-currents constituting the avenue of infection from the primary focus. In view of the remarkable frequency of tuberculous involvement of the tracheobronchial glands it is difficult to explain the comparative rarity of general tuberculous infection. It is certain, however, that, through the medium of the lymphatics, extension of the tuberculous process takes place in neighboring organs, notably the lung.

It is important to bear in mind that in children pulmonary tuberculosis emanating from a diseased bronchial gland presents a somewhat

different clinical picture than in adults as regards the localization of the area of infection. In children the apex is usually uninvolved at first, the infection spreading from the hilus in the immediate neighborhood of the primary glandular focus to the middle and lower portions of the lung. Involvement of the lower lobe is often produced by the aspiration of cheesy portions of gland penetrating a larger bronchus. In the absence of an ulcerating gland within the bronchus, permitting a downward extension of the tuberculous process, the area of initial pulmonary infection is closely adjacent to the bronchial glands, between the second and fifth dorsal vertebræ. An investigation of the middle or lower portion of the back in children is usually attended by positive results. In this region signs of beginning consolidation with bronchial or bronchovesicular respiration and fine or medium-sized moist râles are recognized.

Enlarged tracheobronchial glands often give rise to no physical evidences at the immediate site of their location, but if *pressure symptoms* are exhibited, an early and convincing diagnosis can be made in many instances. In other words, the physical signs referable to the *compression* of a bronchial gland are sufficient in character in connection with associated data, to justify a definite diagnosis as to the nature of the obstruction. The clinical detection, however, of the *enlarged glands themselves* is often impossible, even if of sufficient size to produce pressure symptoms. It is true that in some cases a considerable enlargement of the bronchial glands is possible of recognition, although the mass may be so situated as to exert no pronounced compression upon important structures.

It is claimed by some observers that dulness upon percussion may be recognized in the interscapular space in the neighborhood of the fifth dorsal vertebra, and especially just above this area. I have never been able to detect changes in resonance in this region in cases of suspected glandular enlargement. Many authors deny the existence of such percussion change unless the glands are of extreme size. In a very few instances I have been able to recognize percussion dulness referable to glandular enlargement just below the sternoclavicular articulation upon one side. The percussion change is rendered more pronounced if the head is held well retracted during a deep inspiration. Recognition is easier in young adults than in little children on account of the diminished size of the thymus gland.

But little dependence can be placed upon any circumscribed auscultatory signs supposedly attributable to glandular enlargement. There may be, in some cases, enfeebled respiratory sounds and in others a distinct bronchovesicular element due to conduction through a solid gland. At best both the percussion and auscultatory signs over the site of the tuberculous gland are vague and indefinite, save in instances of very pronounced enlargement. To illustrate certain points to which attention has been directed, I will report briefly the case of a young man which is of exceeding interest in this connection.

The patient, aged twenty-eight years, was sent to Colorado during the latter part of 1905 on account of advanced pulmonary tuberculosis, the symptoms of which immediately followed an attack of croupous pneumonia. At that time there were severe paroxysmal cough, copious expectoration, rigors, fever, night-sweats, and dyspnea. The patient was referred to me in March, 1907, by a prominent physician in

another part of the State, under whose direction he had remained while in Colorado. The average afternoon temperature was 103° F. and occasionally higher. Dyspnea was pronounced, cough severe and markedly paroxysmal, the expectoration amounting to six ounces in twenty-four hours. Upon examination of the chest there was noted a slightly impaired mobility of the entire left side, with inspiratory retraction in the lateral region. The percussion resonance was normal, and there was no cardiac displacement. There was recognized a considerable diminution in the intensity of the respiratory sounds, with very fine moist râles over the entire left lung. Slight moisture was present at the right apex, without evidence of infiltration. Occlusion of the left primary bronchus from a tuberculous mediastinal gland was suggested, and an effort made to detect localized percussion changes. Percussion of the back from the third to the fifth dorsal spine was entirely negative. No deviation from normal resonance was elicited

Fig. 113.—Illustrating area of dulness from enlarged mediastinal glands in a pulmonary invalid exhibiting well-defined physical signs of bronchial compression. (Compare with Fig. 55.)

in the left sternoclavicular articulation with the head held perfectly erect. When it was thrown well back, however, and particularly upon deep inspiration, there was noted upon light percussion a slight but distinct dulness, the outline of which is shown in the accompanying photograph (Fig. 113). There was thus established a positive diagnosis of obstruction to the left primary bronchus near the bifurcation of the trachea by a tuberculous bronchial gland. This was confirmed the following day by the *x*-ray picture (Fig. 55), the enlarged gland being found in close apposition to the sixth dorsal vertebra upon the left side. There was no hoarseness or aphonia, but the laryngoscopic image clearly showed a partial paralysis of the abductors, indicating that the mass was impinging to at least a slight extent upon the nerve controlling the movements of the larynx.

Dr. Levy's report of the laryngoscopic examination follows: "No apparent change in the mobility of the vocal bands upon tranquil respiration. Upon forced inspiration abductor excursion of the left vocal

band, limited to an extent equal to about one-half that of the right; upon phonation a small chink between the vocal bands, due to paresis of the internal thyro-arytenoid muscle; line of approximation was obliquely to the right, owing to exaggeration of the action of the adductor of the left vocal band over the abductor, causing an overriding of the left arytenoid in front of the right.

"*Diagnosis.*—Slight pressure upon the left recurrent laryngeal or left pneumogastric, involving only the abductor fibers, and these but slightly.

"The fibers of the recurrent laryngeal going to the abductors of the larynx are first affected in pressure lesions of this nerve or of the pneumogastric, in accordance with the law laid down by Semon, which is to the effect that when pressure is made upon the recurrent laryngeal, the fibers going to the abductors are first involved, owing to a peculiar susceptibility of these fibers. The first manifestation of pressure upon the recurrent laryngeal, therefore, is abductor paralysis. As the pressure continues the adductors become paralyzed as well, thus giving to the vocal band neither abduction nor adduction, allowing it to remain in what is known as the cadaveric position."

The subsequent progress of the case under the use of tuberculin and an autogenetic vaccine is detailed under Specific Medication.

MESENTERIC GLANDS

Tuberculosis of the mesenteric and retroperitoneal glands, commonly termed tabes mesenterica, is frequently found at autopsy to have been present in little children, even though unsuspected during life. Suppuration takes place far less often than in the glands of the cervical region. Caseation is common, and calcification sometimes occurs. The condition is found with great frequency among the neglected children of the very poor. The patient is usually quite anemic and poorly nourished. The trunk, arms, and legs are thin and wasted, while the belly is quite prominent. The abdominal enlargement is produced more from the coëxisting tympanites than from the direct presence of the glands themselves. Diarrhea is often present, and the stools are offensive, and, as a rule, the appetite and digestion are considerably impaired. The older writers however, speak of "emaciation and voracity combined" in such cases. There are almost always fever, peevishness, and irritability.

As a rule, little is determined upon examination on account of the tympanitic condition of the bowels. The glands are rarely felt. In case of coëxisting tuberculous peritonitis the abdomen may be firm, resistant, and presenting nodular enlargements. In some instances tuberculous involvement of glands is recognized in other regions, notably the cervical and axillary.

This type of glandular tuberculosis often is observed among negroes, and is not infrequent in adults among these people.

CHAPTER LXII

TREATMENT OF GLANDULAR TUBERCULOSIS

While in the past tuberculosis of the cervical lymph-nodes has been subjected to a variety of local remedial efforts, both non-operative and surgical, involvement of the mediastinal, mesenteric, and retroperitoneal glands has not been regarded as amenable to other than constitutional treatment. The general management of all cases of glandular tuberculosis has consisted chiefly of tonic and supporting measures, which in cervical adenitis have been supplemented by local procedures. The present conception of the proper treatment of glandular tuberculosis affords a reasonable belief in the attainment of more satisfying results than formerly. It is now appreciated that a tuberculous gland, no matter how small, may be an active focus for further tuberculous infection, and hence the *necessity* of *instituting without delay* an intelligent systematic course of treatment even to *incipient* cases.

While the lymphatic glands of the neck comprise a group especially suited for surgical interference, the glands of the mediastinum and abdomen, after the diagnosis has become definitely established, sometimes respond to active therapeutic efforts in conformity with comparatively new ideas of management. The modern treatment of glandular tuberculosis may be regarded as general and local.

GENERAL TREATMENT

This form of management embraces the hygienic treatment and the medicinal.

Hygienic Treatment.—The hygienic principles of treatment relate especially to an abundance of outdoor air, exercise, diversion, change of environment, and nutritious food. In glandular infections, as in all other forms of surgical tuberculosis, attention to no single factor is sufficient for the accomplishment of the best results. An out-of-door existence, important though it be, is totally inadequate by itself, but should be combined with such favorable influences as accrue from judicious exercise, with opportunities for recreation and amusement. There should also be an ingestion of food sufficient in character and quantity to appease the cravings of an increasing appetite. It is difficult to conceive of the inestimable benefits derived by little children from a radical change in their immediate surroundings. Removal from the city to the country or the seashore not only permits a greater purity of the air, but affords a natural incentive for more or less unwonted exercise, and provides a means for the enjoyment of unaccustomed sights, which awaken the interest and maintain a buoyancy of spirits in the young. The psychic influence of a novel environment even among the well-to-do is of undoubted value, while such a change is a veritable blessing to the poor, who, since their birth, have been deprived of sunlight, fresh air, proper food and clothing, cheerful surroundings, and uplifting influences.

In a vast number of cases of glandular tuberculosis the actual needs of the child are better subserved by attention to these hygienic features of treatment than through recourse to purely medicinal or surgical management.

By an *outdoor régime* is meant far more than the air permitted to enter sleeping-rooms and hospital wards through open windows. It is not always an easy matter to persuade parents that their duty to the child consists of provision for a *recreative* existence in the open air as the first essential of treatment. The inconvenience of the family, the additional expenditure, and the social or business interruptions are assuredly unworthy of consideration in comparison with the boon granted by virtue of a radically changed environment.

Clinical evidence is now conclusive to the effect that many cases of glandular tuberculosis are clearly susceptible of rapid and permanent cure, through the adoption of an unrestricted out-of-door existence. While this principle of open-air treatment, exclusive of surgical management, is thoroughly recognized, a considerable difference of opinion is entertained with reference to the comparative merits of the sea, inland, or mountain air. The French and English appear to have an abiding faith in the efficacy of *sea air* for children afflicted with tuberculous glands or bones. In the latter part of the eighteenth century the Royal Sea Bathing Hospital was founded at Margate, England. Since then convalescent homes for invalids suffering from so-called surgical tuberculosis have been established upon the seashore of England. At the present time nearly all European countries maintain hospitals upon the coast for invalids similarly afflicted.

Brannan, the prime mover in organizing the work of our single experimental station at Sea Breeze, which is supported by the New York Association for Improving the Condition of the Poor, reports 23 marine hospitals along the Italian shores of the Mediterranean and Adriatic, containing a total of over 10,000 beds.

Calot has described the hospital at Berck-sur-mer, which was founded by the city of Paris in 1860 and now contains 750 beds.

In this institution remarkable improvement has been achieved by one of my former patients, who became afflicted with Pott's disease. While the child was still an infant the father, a physician of New York city, died in Colorado, in 1898, as the result of a severe pulmonary hemorrhage occurring in the course of advanced phthisis. A few years later the child was sent to Berck-sur-mer, where he remained for a period of nearly two years and secured an apparent complete recovery from the tuberculous process. The child was taken daily from the bed and placed upon a truck, which was rolled almost to the water's edge. There he was permitted to lie during the entire day, save under unusually severe weather conditions. This is practised as a routine measure at the several institutions at Berck-sur-mer.

There are several seashore hospitals in South America containing over 800 beds, largely devoted to the treatment of tuberculosis of childhood. It appears that nearly all the countries of Europe and some in South America have been far more ready than the United States to make national provision for the care of little sufferers with various forms of surgical tuberculosis.

Brannan calls attention to the fact that France maintains on her sea-coast fifteen sanatoria, which, with other institutions, open only during a portion of the year, contain 4000 beds. He quotes the reports presented by Armaingand and D'Espine at the International Congress of Tuberculosis in Paris in October, 1905, concerning the work done in the various seaside sanatoria of Europe. During the past twenty years

60,000 children have been treated in these sanatoria in France, 84 per cent. of whom exhibited favorable results; of these, 59 per cent. were regarded as absolute cures, and 25 per cent. as instances of pronounced improvement. Of those absolutely cured, the percentage ranged from 32 in Pott's disease, to 74 in glandular tuberculosis. Nearly all European seaside institutions exclude pulmonary tuberculosis.

The consensus of opinion abroad is strongly in favor of the seaside resorts as opposed to inland climates for the treatment of tuberculosis of childhood. The results already accomplished at Sea Breeze are instructive and inspiring. There has been an almost invariable improvement in the general condition of the children, with a corresponding change in the local lesions. These results have been attained by virtue of the new surroundings in connection with non-operative therapeutic measures. Out of a total of ten cases of glandular tuberculosis, six have been entirely cured and three very much improved. The essentials of treatment at Sea Breeze are constant exposure to the sea air by night as well as day, abundant nourishment, and the establishment of a bright, happy child-life for the little patients. They are allowed to exercise to a remarkable extent, playing and romping in the sand in spite of their physical infirmities.

Halsted, in his paper before the Clinical and Climatological Section at the first meeting of the National Association for the Study and Prevention of Tuberculosis, reports decidedly gratifying results obtained by inland out-of-door management. His early observations concerning the efficacy of the open-air treatment were confined to the "bridge" of the Johns Hopkins Hospital.

Unusual results in surgical tuberculosis have been obtained in the Adirondacks and other eastern inland resorts. Lowman believes that along the borders of the Great Lakes there may be accomplished results in all respects equal to those obtained at the seashore. Morse has called attention to the Convalescent Home at Wellesley, established many years before Sea Breeze, and employing practically the same methods. He asserts from the experience at Wellesley that the sea air is by no means a *sine qua non*, and that children may be expected to do fully as well in the country as at the seashore.

Freeman affirms, from a surgical experience of over seven years in Colorado, and of equal duration in Cincinnati, that moderately high altitudes with dryness offer far greater advantages than the seashore for the treatment of glandular and bone tuberculosis. He reports remarkably fewer cases of tuberculosis of the lymphatic glands in Colorado than in Ohio. Powers, after ten years' residence in Colorado, following an equal period in New York, arrives at the same conclusion.

From an experience of sixteen years in this State I feel warranted in asserting that both tuberculosis of the glands and bones is decidedly infrequent, the vast majority of such patients coming from a distance to avail themselves of climatic advantages. It is highly significant that amidst a large invalid population with innumerable children born of tuberculous parents, exceedingly few indigenous cases of glandular tuberculosis are observed. Even among a moderately large negro population, who in other regions exhibit not uncommonly tuberculosis of all the glands of the body, there are observed in this State but comparatively few instances even of localized glandular infection. It is reasonable to believe that a rarefied, stimulating atmosphere, with many hours of

sunshine, should be more beneficial for individuals with diminished resistance than a climate teeming with fog, frequently saturated with moisture, thus permitting less opportunity for out-of-door recreation.

Waiving at this time any extended consideration of the value of climate in the treatment of glandular tuberculosis, great emphasis should be added to hygienic management in the open air, with ample exercise, as an indispensable therapeutic factor, whether at the seashore, in the country, at the lakeside, or in the mountains.

While the doctrine of conservative open-air treatment for cases of glandular and bone tuberculosis in children is accorded a general acceptance in modern text-books upon surgery, it would seem that the *present teaching* as to the efficacy of fresh air, sunlight, and exercise is considerably in advance of the *actual methods commonly practised* by physicians and surgeons in assuming to direct the destinies of these patients. It is not sufficient to advise in a perfunctory way that the child should be kept out-of-doors. The obligation of the attending practitioner is not discharged until he has urged, in an active personal capacity, the necessity of *change* to the country, the seashore, or the mountains, as may appear most practicable in individual cases. Further, the so-called ambulatory treatment in the open air is not alone applicable to cases convalescing from operation, but in many instances is equally appropriate for conditions formerly supposed to demand immediate operative interference.

The vital consideration, irrespective of age, is the greater resistance to tuberculosis accruing from an outdoor existence in favorable climates, with suitable provision for diversion, recreation, and exercise.

Apropos of the present conception concerning the vast importance of the purely hygienic principles of management, it is of considerable historic interest to review the practice in vogue in the early centuries, based upon an abiding faith in the efficacy of the kingly touch in the cure of scrofula. The antiquity of the belief has been established, together with a mass of almost credible evidence as to its value.

In France the practice dates back to the time of Clovis in 481 A. D. In England this method of treatment was introduced by Edward the Confessor, who reigned from 1044 to 1066. The disease was commonly regarded as "a vice in the system," and possible of eradication only through the purification afforded by the royal touch. Scrofula, therefore, was popularly called "the king's evil." During a period of seven hundred years this custom was followed by the reigning monarchs of England and consisted of the laying on of hands. Henry the Seventh originated the plan of tying a ribbon around the neck, to which was attached either a silver or a gold coin. Historians differ as to the performance of the practice by Mary, William, and Ann. It was believed by many people that these rulers did not possess the hereditary gift of healing, for the ascribed reason that they did not occupy the throne by Divine right. Writers of history assert that multitudes came from great distances to avail themselves of the wondrous benefits to be acquired through the sovereign touch. Charles the Second is reputed to have treated in the neighborhood of 100,000 people suffering from the king's evil during a period of twelve years. Louis XIV. of France, upon Easter Sunday, 1686, is reported to have treated over 1600 people. That a not altogether implicit faith in the efficacy of the method was entertained by the French ruler is suggested by the words, "The king has touched you, may God cure you."

John Browne, Chirurgeon in Ordinary to his Majesty of England in 1684, has written several treatises concerning "the real art of healing strumæ by the imposition of the sacred hands of our kings of England and France given them at their inaugurations." Dr. H. F. Stoll has recently called attention to the interesting fact that although Browne lived in an age of superstition and frequently assisted the king in the ceremony of royal touch, he, nevertheless, stated in his writings that the malady was "no fictitious distemper or imaginary evil, but rather a proper disease."

In the light of our present knowledge regarding the probable elasticity of the term "scrofula" as then applied, and also concerning the beneficial effect of travel, life in the open air, and buoyancy of spirits, it is not unlikely, as Halsted suggests, that the prolonged pilgrimages from remote points, the protracted journeyings in the open air, the invigoration incident to changed surroundings and renewed hope, served effectually to delude the sufferers as to the efficacy of this supernatural method of healing.

Medicinal Treatment.—For many years the purely medicinal treatment of glandular tuberculosis has related largely to the administration of iodid of iron and cod-liver oil. With no desire to detract from the undoubted value of these remedies, in a large majority of cases it is, nevertheless, true that the benefits to be derived from their use are decidedly inferior to the results afforded by general hygienic management. Medicinal agents of any kind are not indicated invariably in these cases, and when employed at all, should not be prescribed in accordance with a conventional or routine method. Attention to digestion is of the utmost importance. The correction of such disturbances through dietary precautions and medicinal aids is of much more value than the administration of cod-liver oil, arsenic, or the ferruginous tonics.

The appetite is usually capricious at best, and the digestive function more or less enfeebled. In such cases the indications point more to the consumption of greater quantities of nutritious food than to enforced dosage with drugs. In the absence of distinct contraindications, however, it is excellent practice to use the syrup of the iodid of iron, alternating occasionally with Fowler's solution, given well toward the limit of toleration. The various preparations of iron, manganese, cod-liver oil, or easily digestible fats are often of undoubted value, provided that appetite and digestion are not impaired. Aids to nutrition in this, as in other forms of tuberculosis, may be expected to increase vital resistance.

Specific medication of unquestionable merit, applicable to all forms of glandular and bone tuberculosis, has recently been employed. The administration of the bacilli emulsion of Koch to cases of glandular tuberculosis opens an entirely new therapeutic field and is, perhaps, destined to yield gratifying results in many cases thus far but little amenable to management. Wright's work adds confirmation to the value of this agent as applied to nearly all cases of surgical tuberculosis. Although his reported results suggest the predominant value of the new tuberculin in cases presenting a localized focus of tuberculous infection, as in tuberculous bones and joints, highly satisfactory results are sometimes obtained in carefully selected cases of pulmonary tuberculosis.

With the addition of the bacilli emulsion to the armamentarium

of the physician, the future of children afflicted with enlargement of mediastinal and mesenteric glands is rendered somewhat brighter. After a provisional establishment of the diagnosis by the subjective and objective signs, together with the use of the *x*-ray, ample justification is afforded for the cautious administration of the tuberculin.

LOCAL MEASURES

Local efforts, limited to the cervical glands, relate to—(1) Non-operative measures, embracing counterirritation, massage, electrolysis, the *x*-ray, and (2) surgical procedures, including aspiration, interstitial injections, incision, and drainage, with or without curetment or cauterization, and, finally, complete excision.

Local non-operative measures should consist primarily of efforts to remove, as far as possible, all sources of infection. It is of essential importance to investigate the condition of the tonsils, pharynx, teeth, nose, ears, and scalp. Hypertrophied tonsils containing deep crypts should be removed immediately. Excellent results are sometimes obtained by painting the tonsils and posterior pharynx with solutions of iodin containing potassium iodid. There is no doubt that benefit is obtained by the use of disinfecting, stimulating, and astringent applications to these parts. Attention should be given to catarrhal conditions of the nose and inflammations of the ears and scalp. Stark and Koerner, according to Dr. Leonard Freeman, found decayed teeth in 41 per cent. and 73.8 per cent. respectively in their cases of glandular tuberculosis.

Counterirritation by ointments or stimulating solutions containing preparations of iodin, ichthyol, and resorcinol is still extensively employed, although its utility is extremely doubtful and quite unsustained by practical results. The use of these external applications must be regarded rather in the nature of a *placebo*, but the necessity for such practice seldom exists. In addition to the negative effect there is usually entailed a loss of valuable time before the institution of rational measures, during which period the patient is exposed to the constant danger of further infection.

Massage of the glands is unworthy of other than condemnatory mention. The practice of manipulating the structures is distinctly dangerous upon the score of increasing the possibility of further dissemination.

Electrolysis has been found uniformly ineffective, its employment being based upon the densest ignorance, or constituting a form of unjustifiable deception.

The *x-ray* is of undoubted efficacy in the treatment of many cases of cervical adenitis. I have seen tuberculous glands of large size disappear entirely under the systematic employment of this agent, but it should be borne in mind that such method of treatment is applicable only to carefully selected cases, as there are certain limitations and restrictions even to its special employment. Its practical utility is dependent largely upon the discrimination exercised concerning the character of cases to which it is applied. Its successful use does not depend so much upon the size of the gland, as upon the nature of the pathologic structure. It is of special value when the glands are firm, adherent, and devoid of any apparent inflammatory condition. In the presence of softening or caseation, however, the remedy is ineffective and involves an unnecessary delay before the patient is accorded the benefit of much-

needed surgical interference. Under such conditions there is no promotion of absorption by the *x*-ray, and, therefore, no positive diminution in the size of the enlargement. Inasmuch as it is sometimes extremely difficult to determine with accuracy the pathologic state of deep-seated tuberculous glands, it follows in doubtful cases that failure to secure positive results from the *x*-ray after a few weeks' trial should be accepted as definitely conclusive of their inefficacy. A well-founded suspicion of softening is sufficient to contraindicate even its initial employment. The value of *x*-ray exposure, however, is conceded following extirpation of glands, the post-operative treatment being worthy in all cases of careful consideration. Despite a seeming thoroughness of the operation, a glandular swelling not uncommonly reappears in the immediate region of the wound. Such possibility is somewhat more remote provided several exposures of the *x*-ray are permitted once or twice a week following the operation. In the event of a renewed glandular enlargement the systematic employment of the *x*-ray is indicated prior to an immediate repetition of the operation. It is hardly necessary to add that treatment by this method should be received only at the hands of a skilled and experienced radiographer. Care should be taken that the decision concerning the character of the treatment, whether of surgical nature or by means of the *x*-ray, should not be made upon the basis of the presence or absence of a resulting scar. Too often parents and physicians are prevailed upon to discountenance operation, and elect the *x*-ray form of management through fear that a disfiguring scar may follow complete excision. It cannot be impressed too strongly that this is an entirely subordinate consideration, and should have no place in the mind of the medical attendant in a decision as to the choice of procedure, even with reference to the female sex. As a matter of fact, unsightly appearances, especially capillary dilatations in the form of telangiectases, sometimes result when under the care of competent radiographers. The reader is referred to plate 11, representing the disfigurement occasionally observed from the use of the *x*-ray.

Upon the whole, while the utility of the *x*-ray for the treatment of a class of tuberculous glands has been fully demonstrated, its exact place from a therapeutic standpoint must still be regarded to some extent as *sub judice*.

Surgical Procedures.—Among the purely surgical procedures should be mentioned especially incision with drainage and complete extirpation.

Aspiration of the fluid contents, with or without the later injection of various preparations, has been attended with almost invariable disappointment. Solutions of iodin, phenol, alcohol; silver nitrate, guaiacol, camphorated naphthol, balsam of Peru, cinnamic acid, iodoform, and zinc chlorid, when injected into the tissue of the gland, often produce considerable discomfort, and at times give rise to dangerous symptoms.

Nearly fifteen years ago I tried in several instances the injection of iodoform dissolved in ether, and in one case suspended in olive oil, with, upon the whole, unsatisfactory results. At best this practice is regarded as unwarrantable. It is distinctly evasive of the more immediate indications, and involves a continued waste of time, which sometimes constitutes as well a loss of opportunity.

Simple incision is indicated in cases of acute glandular tuberculosis exhibiting unmistakable evidences of softening. As soon as suppuration

occurs and is rendered possible of detection by fluctuation, the abscess, however small, should be opened. The incision should be of no greater length than necessary to insure complete evacuation of the pus and subsequent drainage. In order to render the scar but slightly conspicuous, surgeons should open superficial abscesses, when possible, by a horizontal incision, thus insuring its concealment by the collar. The horizontal incision is also preferable to the longitudinal, for the reason that the resulting scar is less likely to be reddened and hypertrophied on account of the diminished traction incident to the frequent turning of the head. If the abscess is deep, the direction of the incision, however, must be determined with reference to the position and course of the blood-vessels, surgeons prefering an oblique downward and forward incision at the upper part of the neck, but a transverse one in the lower portion. Precaution should be taken not to insert the knife too far into the tissues of the neck. Either a pair of blunt-pointed scissors or a grooved director should penetrate the fascia in a search for the suppurating cavity. After the insertion of the scissors or forceps into the abscess, the fascia should be torn and stretched by withdrawing the instrument opened, thus avoiding the danger of injury to immediate structures.

Curetment is sometimes employed, especially in cases of large abscess formation, and is particularly applicable to gland sinuses with a probable mixed infection. When prolonged anesthesia and radical surgical intervention is precluded by the general condition, it is occasionally permissible to attempt the disintegration of glands by this process, the results varying according to the thoroughness with which the glandular tissue is scraped away. To remove this entirely without penetrating the adherent capsule is well-nigh impossible, while considerable traumatism may result, not only involving possible injury to immediate blood-vessels, but also producing a rapid extension of the tuberculous infection to other parts.

Mayo recommends the application of iodoform emulsion or tincture of iodin following incision and curetment, and an immediate closure of the incision in order to avoid prolonged drainage. Sinuses are stimulated with phenol in order to effect as complete sterilization as possible. Gould prefers the application of a solution of zinc chlorid, 40 grains to the ounce, as an efficient germicide. In many cases it is sufficient to pack lightly the cavity with iodoform gauze for a few days. The operation is simple, necessitates but a small incision, and leaves, as a rule, no disfiguring scar. There is but little danger of penetrating the capsule and injuring veins, arteries, or nerves, provided a blunt spoon curet is employed. The deficiencies of the operation relate to its unreliability and the possibility of further tuberculous extension.

Total excision of tuberculous glands is, in the majority of instances, the operation of choice. This time-honored procedure is said to have originated with Galen, and to have been employed by Paré. It is of some interest to note, however, that for several hundred years up to the latter part of the nineteenth century, the attempt to remove enlarged glands of the neck was quite uniformly deplored. Cooper, in 1815, objects to the practice "because the removal of a scrofulous gland can hardly be said to do much good to a patient whose whole system is under the influence of strumous enlargement." Druit, in his "Modern Surgery," published in 1841, states that "it is sometimes expedient to extirpate one or more glands," but deprecates such effort in nearly all cases. Miller, in his "Principles of Surgery," published in 1853, says:

"It is almost unnecessary to state that chronic enlargements of lymphatic glands by tuberculous deposit in the neck are not to be made the subject of severe operation, discussed, they may be, or by suppuration they may be broken down and extruded, but extirpation is, in truth, but reckless and unwarrantable cruelty, injurious to the patient, surgeon, and surgery." Erichsen and Ashhurst, in 1869, state that "excision of enlarged cervical glands is seldom necessary, and advise against undertaking the operation unless the disease has been of many years' standing and the glands very large." In 1873 Hamilton, in his "Practice of Surgery," says: "Excision has in all cases been followed by a speedy return. After the most thorough extirpation, new glandular enlargements have soon been presented." He urges the limiting of operation to cases "in which only one or at most only a few adjacent glands are involved, and then not until the size and relation of the tumor immediately imperils life." In 1881 Savory and Roberts, in Holmes' "System of Surgery," state: "Should the tuberculous gland be removed by operation? Hardly ever. The operation can be justified only when the glands have remained for a very long time stationary in spite of all local measures and constitutional treatment, and when it is an unsightly deformity or not connected with diseased glands more deeply situated."

Such teaching in comparatively recent years, denying the rationale of complete excision of tuberculous glands, is somewhat startling in view of our present knowledge regarding the relation of lymphatic enlargements to pulmonary tuberculosis and general miliary infections. Groben, after an analysis of the statistics of several clinicians, reports that pulmonary tuberculosis developed in 75 per cent. of all non-operated cases, and in less than 15 per cent. of those undergoing excision. The conclusions of other observers hardly bear witness to these results, but the evidence remains irrefutable that the proportion of cases developing other foci of tuberculous infection is much larger in patients denied the benefit of active surgical interference. In this connection it is of much interest to read the remarkable words of John Browne, of whom mention has been previously made, apropos of healing by "royal touch," as quoted by Stoll. In the seventeenth century he says: "These tumors do require extirpation and extraction. . . . to be so dexterously performed as that no part be left behind. . . . Our greatest advice in the use of the knife is to have a particular and special care to the vessels bordering upon the parts, namely, the nerves, veins, and arteries, lest they be injured thereby. The glands are to be extracted with great care and caution, so as no vessel whatsoever be injured by the operation; and if any flux of blood may happen in this operation, it is presently to be stopped with restrictives, and this method is to be prosecuted till every part of the cystus or bags thereof are perfectly and thoroughly eradicated and extracted, the which being done and the part clean, mundifie the ulcer, digest, incarn and then induce a cicatrix."

It is scarcely within the province of this book to elaborate the technic of the operation. It is sufficient merely to call attention to several important considerations in connection with the principles of surgery as applied to glandular tuberculosis.

A large proportion of cases of cervical adenitis are suited to radical operation. The existence of a moderate pulmonary infection does not in itself offer any distinct contraindication for operative interference. If the pulmonary involvement is not far advanced, the indications for oper-

ation are emphasized by the very fact of its existence. Added opportunities for recovery are offered by virtue of the removal of an important and often primary focus of infection. The supposed danger of anesthesia to the consumptive has been found by actual experience to be largely a myth. I do not recall a single instance of unfortunate results of chloroform or ether anesthesia among the many phthisical patients undergoing operation for various causes.

Complete extirpation of tuberculous glands is often one of the most difficult and tedious operations which the surgeon is called upon to perform. It should not be undertaken by other than those possessing an excellent technic and thorough familiarity with the anatomic relations. A most important consideration is the complete and thorough removal of all affected glands. To this end search must be made patiently and carefully in the midst of highly important structures for almost innumerable glands not originally detected.

Much has been written about the advantages and disadvantages of the various forms of incision. Some surgeons recommend several small ones, either oblique or transverse; others urge large sweeping incisions, either of the letter Z or letter S shape, or conforming to a simple transverse curve across the upper portion of the neck. No conventional incision is applicable to all cases. The essential desideratum is to have plenty of room, and this demands a large opening, extending in many cases from the mastoid to the clavicle, regardless of subsequent deforming cicatrix. To avoid injury to important parts the dissection should be made as much as possible with a blunt instrument. Care should be taken to remove the glands intact without rupture of their capsule, in order to prevent all danger of disseminating the infection through contamination of the wound. This possibility, together with the danger of injury to nerves and blood-vessels, represents one of the disadvantages of the operation. Its thoroughness, however, more than offsets any objections incident to its severity. It is essential to remove with a wide excision all gland-bearing fascia. A subcuticular suture will lessen the prominence of the scar.

Further discussion of the surgical details is inappropriate in connection with a work devoted to pulmonary tuberculosis. It is permissible to allude briefly to the danger of wounding veins, arteries, and nerves.

The chief parts liable to injury are the jugular vein and the spinal accessory nerve, together with the pneumogastric, phrenic, laryngeal, sympathetic, and the facial.

A somewhat unique accident, occurring in the course of operation, came under my observation seven years ago. A young man consulted me in January, 1900, with reference to a tuberculous enlargement upon the right side of the neck the size of a hen's egg. He had been operated upon in 1891 by Dr. W. T. Bull, who removed a large mass from the left side. I advised immediate operation for the right-sided involvement, and referred the patient to Dr. Powers. The patient, however, after some delay submitted to operation at the hands of a surgeon in another locality. I was not present at the operation, but was informed subsequently that there was profuse hemorrhage and that, by means of an aneurysm needle, the deep vessels were tied with heavy silk ligatures. It was found impossible to complete the operation after this on account of the collapse of the patient. Upon recovery from the anesthetic there were distressing spasmodic cough and aphonia. The severe cough was practically constant for several days, while the loss of

voice persisted for some weeks. After a gradual subsidence the cough was quickly excited at all times by gentle pressure in the region of the wound. About five weeks subsequent to the operation the patient again came under observation and the further management was directed by Dr. Powers, who reported the case at length. On account of the unsatisfactory condition of the patient, it was not thought wise to attempt any surgical interference until January of the following year. Powers reports: "The scar on the right side of the neck was exceedingly irritable, even slight pressure at any point in its upper third occasioned severe spasmodic coughing. Nearly a year following the previous operation the end of a heavy silk ligature presented at the upper end of the sinus. Traction with an artery clamp occasioned intense coughing, pain, shortness of breath, and vomiting." During the operation, which followed shortly, the loop of the ligature was found surrounding a large mass of granulation tissue, in the midst of which lay the pneumogastric nerve. "The slightest interference with this portion of the wound and the slightest traction of the ligature brought on alarming coughing and cyanosis." The patient made a good recovery. Some months after the operation the tendency to cough upon pressure at the site of the wound almost disappeared. During the last few years his recovery has seemed apparently complete, until a recent appearance of glandular enlargement, for which the bacilli emulsion is being administered at the present time.

The tendency to recurrence should always be borne in mind. Mayo has pointed out that the term *recurrence* is used improperly in that the enlargement is due to the growth of new glands, rather than to an impossible reappearance of glands once removed. It should be made clear to the patient and friends that the excision of enlarged glands offers no positive assurance that other glandular structures previously quiescent may not come to the front in due time, and present themselves in the neighborhood of the former site. The percentage of recurrences varies from about 25 to 70, as reported by several observers. Mayo reports that during the past four years there have been operated in Rochester 235 cases for primary tuberculous enlargement of the glands, and but 15 cases for secondary involvement.

The return of the trouble is not always due to a lack of skill or knowledge on the part of the operator at the time of the initial operation, nor is it dependent necessarily upon an impaired condition of the patient.

I recall the case of a young man who consulted me in 1896, immediately upon arrival in Colorado, on account of moderately enlarged tuberculous glands of the left side of the neck. There was no evidence of tuberculous lesion elsewhere, the general condition was unusually robust, the patient was plethoric, and nutrition was unimpaired. An operation which lasted several hours was performed very patiently and skilfully by Dr. Edmund J. A. Rogers. During the next few years four different operations were performed by the same surgeon for enlarged tuberculous glands upon each side of the neck, the general condition remaining unimpaired, with no evidence of tuberculous infection in other parts of the body. Enlarged glands continued to appear, however, with but little delay, following each operation, and there finally developed an acute miliary infection which terminated his suffering.

It is a reasonable assumption that had this case been observed after the discovery of the *x*-rays, better results might possibly have been obtained from their employment as a postoperative procedure.

SECTION V

TUBERCULOSIS OF BONES AND JOINTS

CHAPTER LXIII

ETIOLOGIC AND PATHOLOGIC CONSIDERATIONS

THE etiology of tuberculosis of the bones and joints is not especially different in its essential characteristics from the conditions giving rise to involvement of other parts of the body.

The pathologic condition is due primarily to the presence of the tubercle bacillus in the affected part, although the manner of its introduction to the seat of the disease is not always entirely clear. A somewhat obscure conception as to the precise method of infection, arises by virtue of the supposed protection of the parts from an anatomic standpoint, the dense structure, the frequent sharp localization of the diseased area, and the failure to discover a possible neighboring focus of tuberculous infection. Further confusion results from the promulgation of the theory of a strong hereditary influence in determining the development of the disease. The acceptance of certain clinical data also affords ground for widely differing opinions regarding the etiology. It is well known that the great majority of cases of tuberculosis of bones and joints develop in early life.

Billroth reports one-third of all cases to have occurred during the first ten years of life, and one-half before the twentieth year. Whitman reports, out of a total of 5461 cases of tuberculous disease under treatment at the Hospital for Ruptured and Crippled, that seven-eighths of the patients were under fourteen years of age and that 85 per cent. of those recently treated were in the first decade of life. The fact remains, however, that it not uncommonly develops among apparently strong and healthy individuals without any evidence of preëxisting tuberculous disease or other assignable cause. I have had occasion to note, in a rather surprising number of cases, the so-called idiopathic development of tuberculous processes in bones and joints among adult robust farmers and others accustomed to physical activity in the open air.

The rôle of trauma, with or without penetrating wounds, constitutes another etiologic phase susceptible perhaps of varying interpretations. Slight concussion without visible wound has been followed by distinct infective processes, while severe contused or penetrating injuries have often occasioned no evidence of tuberculous bone lesions despite the presence of apparently similar conditions.

Incised wounds have been known to heal promptly with the speedy subsequent appearance of a localized tuberculous process in individuals presenting every external appearance of vigorous health. On the other hand, invalids with advanced pulmonary tuberculosis rarely develop bone or joint lesions. Further, the parts most frequently affected are those least liable to external injury. Tuberculous lesions of the lower

extremities are observed much more often than of the upper, although the latter are far more likely to undergo injury.

Upon the basis of the above established truths it is somewhat difficult to formulate a consistent theory as to the precise method of invasion of bones and joints capable of application to all cases.

A studious analysis of the available data upon which to base conclusions justifies the assumption that in the majority of instances the affection of the bones is secondary to an antecedent tuberculous focus, and that the involvement of the joints is in most cases a simple peripheral extension from a tuberculous osteitis. It is undoubtedly true, however, that local tuberculous processes may sometimes originate within the joint without previous involvement of the bone. Primary tuberculosis of the synovial membrane is described by various observers, and is believed to be a not uncommon condition of the knee-joint in adults. It is reasonable to assume, however, from the observations of Nichols, that painstaking investigation would disclose the presence of foci in the osseous tissues antedating the joint involvement. Contrary to the opinion entertained by many that the infective material is conveyed to the part through the circulatory channels, it is held that the route chiefly traversed by the bacilli is along the lymphatics. Were the vascular system the chief medium for the distribution of the infective agent, it would be natural to expect a more general involvement. Neither failure to discover a previous tuberculous focus in the neighborhood of a bone or joint lesion, nor absence of a visible infection atrium in the skin affords any valid argument in favor of the primary nature of the process.

That infections, metastatic in character, may take place in these parts via the lymphatics and circulatory systems is illustrated by the observation of joint disturbances in rheumatism, gonorrhea, and toxic arthritis.

However, in all these affections the frequent localization of the process in a single joint strongly suggests the rather predominant influence of the lymphatics as compared with the vascular channels. It is scarcely necessary to recognize definitely the site and method of invasion or to demonstrate the presence of antecedent tuberculous foci as points of departure of bone and joint lesions, in order to substantiate their secondary character. It has been shown in previous chapters that glands may present every external appearance of a normal condition, and yet contain imprisoned bacilli constituting latent foci of infection. It is easy to conceive that under a quickly developing inflammation attending such acute infectious diseases as diphtheria, measles, scarlet fever, and whooping-cough, the glandular tumefactions may be sufficient to produce a rupture of the capsule, giving rise to further tuberculous dissemination, and yet disclose no subsequent macroscopic evidence of involvement.

Cornet has quoted the results of 67 autopsies performed by König-Orth. In 53 cases, or 79 per cent., there were found tuberculous lesions besides the bones and joints, but in 14 cases no other tuberculous foci were discovered. The lungs were involved in 37 instances, the glands in 21, and the genito-urinary apparatus in 9. He also cites Dollinger's and Unger's statistics with respect to the frequency of hereditary transmission, the former reporting a direct inherited taint in 97 out of 250 cases, the latter in 11 out of 54. These proportions are much smaller than the

reported experience of many observers. In Dollinger's statistics a history of tuberculosis was inclusive of the four grandparents, as well as the father and mother. The frequency of tuberculosis in the parents of children afflicted with bone or joint lesion is certainly much greater among the cases that I have been permitted to observe in Colorado. I can recall but few instances of bone or joint infection in children up to seven or eight years of age, one of whose parents was not the subject of a non-arrested pulmonary tuberculosis at the birth of the child. In almost every case in which this was not true one or both parents were victims of some other disorder impoverishing nutrition and greatly impairing vitality. The theory that the influence of heredity relates to a diminished cell resistance rather than an imparted disease is not restricted in its application to the existence of tuberculosis. It is clear that a deficient vitalization with increased vulnerability of tissue may be imparted at the time of conception as a result of other debilitating conditions. During the first few years of life, at the very age when glandular tuberculosis is most likely to develop, the combative phagocytic power of the cells is less pronounced than after growth has been attained. The child has emerged from the successive periods of undue susceptibility occasioned by repeated digestive disturbances and acute inflammatory conditions of the nose and pharynx, including hypertrophied tonsils and adenoids. Finally measles, pertussis, scarlet fever, bronchopneumonia, recurring bronchitis, and influenza produce a general enfeeblement of the system, and excite latent tuberculous foci to renewed activity. In other words, the occurrence of tuberculous bone and joint lesions during early life is the direct and demonstrable result of a preëxisting focus of infection, from which points of departure are permitted through lowered individual resistance. At this age the latency of tuberculous infections is maintained with more difficulty, as the natural constructive processes are less pronounced, the lymph-spaces more permeable, allowing more ready distribution of bacilli, and the vulnerability of the tissues definitely increased. The prevalence of tuberculosis in infancy and childhood, together with its excessive fatality, affords *a priori* a rather convincing argument as to the verity of Behring's theory regarding infection through the intestinal tract at this age, and in many cases the persistence of latent foci to adult life.

The origin of local bone and joint tuberculosis in adult years is often traceable to trauma. Whitman alludes to the experience of Hildebrand, König, Mikulicz, and Bruns, who report, out of a total of 3398 cases of osseous and joint tuberculosis, 513 properly attributable to trauma. Krause has shown that the cancellous tissue is made more vulnerable to the action of tubercle bacilli following an injury. In but exceptional cases, however, is there afforded through this means a direct gateway of infection. It may be assumed as an almost universal condition that a means of invasion had already been established through some other channel, and that the cellular resistance had thus far been sufficient to hold the infection in abeyance.

Through the influence of slight traumatism the defensive power of the tissue-cells is diminished by virtue of the new inflammatory condition. If the injury is severe, however, the invaders are repelled more readily as a result of the increased resistance incident to the excessive local congestion arising from the trauma. In this event the increased phagocytosis is somewhat analogous to that attending the

congestion produced by the so-called Bier treatment of chronic inflammation of the joints.

The order of frequency of tuberculous lesions of the bones and joints, established by a review of the statistical reports of various institutions, shows the vertebræ to be affected in nearly one-half of all the cases, the hip-joint, in from 30 to 35 per cent., with involvement of the knee, ankle, wrist, elbow, and shoulder decidedly less frequent.

The microscopic pathology of bone and joint tuberculosis is not essentially dissimilar to that obtaining in other parts of the body, although, owing to the greater density of the histologic structures, the process is of slower development than tuberculous lesions elsewhere. Circumscribed tuberculous nodules composed of individual tubercles are produced. Within the tubercle deposit are found cells of various shape, the epithelioid variety usually predominating. Masses of polynucleated giant-cells are also present. Bacilli are observed both within and without the various cells. Round-cells are numerous within the tuberculous structure. With increasing development of the tubercle, which takes place by extension in the periphery, retrograde changes occur in the center. With the appearance of polynucleated leukocytes a degenerative process supervenes, followed by caseation and softening. As a result of the coalescence of numerous tubercles, each undergoing in the center degenerative change and softening, abscess formation eventually takes place. The suppurative process represents, therefore, the center of the entire tuberculous mass, while a new tuberculous development takes place at the outer margins. Suppuration results not solely from the action of the tubercle bacilli, but often from the added presence of some other microörganism, notably, the staphylococcus. The development of secondary or mixed infection is usually attended by greater infiltration of adjacent tissues and increased suppuration.

Fibrous tissue metamorphosis sometimes occurs, inducing varying periods of quiescence of the tuberculous process. This may continue as a partially arrested degenerative change in the bony structure, undergo calcification, or finally remain encapsulated as a cold abscess. Through the influence of an aggressive phagocytosis the destructive progress of the tuberculous bone lesion is sometimes interrupted. On the other hand, the tubercle deposit may produce softening and subsequent absorption of the bony trabeculæ. With increasing formation of granulation tissue there ensues an osseous necrosis. Caries of bone thus established is associated with the detachment of destroyed portions which takes place either in small particles or in the separation of a definite sequestrum.

As a rule, the tuberculous deposit occurs primarily in the short bones or in the extremities of the long bones. When the short bones are attacked, especially the phalanges and metacarpi, the tuberculous infiltration involves the medullary tissue, giving rise to the term *tuberculous osteomyelitis*. In the long bones, as the femur and tibia, the deposit of tuberculous material takes place, as a rule, in the epiphysis or immediately adjacent to it. In caries of the ribs and vertebræ the initial tuberculous involvement is directly beneath the periosteum, producing erosion and sometimes extensive destruction of the osseous tissue. Bone tuberculosis occurring as a part of an acute general miliary infection has but slight, if any, clinical interest.

The process originating in the epiphysis of the long bones extends

peripherally in all directions, and often advances to the articular or joint surface. The entire cartilaginous attachment occasionally becomes loosened and separated *en masse* from the bone. In the event of infection of the synovial membrane there results a diffused infiltration of the surface and occasional nodular formation. With further degenerative change there is found a deposit of tuberculous granulations, with erosion of the cartilage, and progressive infection of neighboring tissues as a result of the capsule perforation. After this has taken place the secondary changes in adjacent structures partake of fibrous tissue proliferation, which results in greater or less fusing of the muscles and tendon-sheaths, thus retarding still further the mobility of the joint. In addition to adhesions produced by the organization of fibrinous deposits there often ensues the formation of bony new-growth from periosteal irritation. Fluid may accumulate in the joint in varying amounts, the exudate containing broken-down caseous material and sometimes flocculent coagula. Attention is called to the widely varying character of the joint lesions, which, as previously stated, are sometimes apparently primary in character.

Both the prognosis and treatment are largely dependent upon the extent and character of the tuberculous involvement of the articular surface. In proportion as the synovial membrane of the articulation is thickened and the cartilage perforated will there be increased restriction of motion, added difficulty in securing arrest, and increasing danger of subsequent tuberculous dissemination through the retention of infective general detritus.

CHAPTER LXIV

CLINICAL MANIFESTATIONS OF BONE AND JOINT TUBERCULOSIS

Early Symptoms.—The symptoms of bone and joint tuberculosis are worthy of separate consideration. The early manifestations of *osseous* tuberculosis affecting the long bones are often exceedingly indefinite. A sense of vague discomfort in the limb is frequently experienced as an initial symptom. An enlargement of the bone is noted which is usually unilateral. Moderate tenderness is often present, and when marked over a circumscribed region, abscess formation external to the bone may be suspected. Tuberculous enlargement of the small bones, especially the phalanges, is often capable of very early recognition, the shape of the fingers being exceedingly characteristic. The affection is seldom confined to a single finger. The phalanges are distinctly spindle shaped, conforming to the appearance commonly observed in hereditary syphilis, but the latter condition, as a rule, may be excluded by the absence of associated evidences of a specific taint. There is rarely pain, and but occasional abscess formation, in this variety of bone tuberculosis.

In tuberculous periostitis affecting the rib, pain is sometimes, though not always, experienced. Suppuration is almost constant, and a small

localized tumor is recognized. The skin is reddened, and fluctuation is present.

In *joint* tuberculosis the swelling and pain may be acute in some cases and almost entirely absent in others. The pain may even be referred to points remote from the affected joint. The symptoms are largely dependent upon the degree and nature of the pathologic change upon the articular surface. Complaint may be made at first of but mere uneasiness or discomfort of the limb, without especial localization in the joint, this being particularly true of hip disease. As the disease progresses an effusion takes place, and limitation of motion, together with actual pain, results upon movement of the joint or the imposition of weight. Swelling of the affected articulation is noted upon inspection, together with a relative increase of heat upon palpation in comparison with the corresponding joint of the other side. In addition to the physical evidences of synovial effusion sometimes present a general inflammatory condition, commonly described as doughy, is

Fig. 114.—Cicatrix after operation for caries of rib, which was followed after some months by development of pulmonary tuberculosis.

recognized in the immediate neighborhood of the joint. More or less deformity takes place, and the limb assumes a position of partial flexion. Reflex pains are now more pronounced, though local tenderness is usually present. As the morbid changes within the joint advance to perforation or increased thickening of the membrane and cartilage, abscess formation results and even ankylosis.

Generally speaking, the diagnosis of tuberculous joint lesions in children is confounded principally with that of rheumatism. Unfortunately, the tendency is quite common to regard many of these cases as instances of simple rheumatism, and much valuable time is lost before the patient receives the benefit of rational management. It should be remembered that single joint inflammation in children points strongly toward a lesion of tuberculous character. The slow onset, without immediate temperature elevation or acceleration of pulse, together with flexion of joint and muscular rigidity, also are almost conclusive evidences of tuberculous joint disease.

The **prognostic considerations** relate to the danger of further dissemination of the tuberculous infection, directly endangering life, and to the character of the local changes involving deformity, impaired function, and injury to neighboring structures. The probability of extension of the tuberculous infection from bone and joint lesions is considerably less than the likelihood of dissemination from primary foci in the lymphatic glands and lungs. The influence of tuberculous joint lesions upon the ultimate prognosis is, of course, dependent largely upon the location of the diseased area, involving a separate consideration of the affected joints.

It is manifestly impossible in a book of this character to consider at length the clinical aspects of tuberculous affections of the various parts of the body. It is sufficient to call brief attention to some of the more salient features of caries of the spine and tuberculosis of the hip- and knee-joints.

Caries of the spine, consisting of tuberculous involvement of the anterior portion of the body of the vertebra in various portions of the spinal column, is not only more frequent than other varieties of bone and joint tuberculosis, but is relatively more important. This is due to the proximity of the diseased area to highly important structures. The results of the affection are not confined in all cases to the immediate neighborhood of the tuberculous process. In some instances not only the thoracic and abdominal organs are involved, but often the entire body.

The extent and character of the deformity and the degree of compression of vital organs depend to a great extent upon the precise location of the disease in the spinal column—the nearer the middle of the spine, the greater and more unfortunate the deformity. The dorsolumbar region is the portion most frequently affected. The proportion of involvement of the various regions of the spine is in the neighborhood of 60 per cent. for the dorsal, 25 to 30 per cent. for the lumbar, and 7 to 12 per cent. for the cervical.

A concise review of the symptoms and signs of *early Pott's disease* should be of special interest to the general practitioner. The prevention of deformity and of the resulting compression of the thoracic and abdominal organs, with impairment of vital functions, is almost entirely dependent upon the early recognition of the condition. An angular projection has ever been regarded as the chief characteristic sign of Pott's disease, and the diagnosis has often been delayed until the enforced detection, by this means, of a destructive process already considerably advanced. As a matter of fact, the early symptoms of the disease are sufficiently characteristic to permit a positive conclusion as to the nature of the affection long before there is encountered irregularity in the contour of the spine. Occasional complaint is made of pain produced by sudden jars, and referred not to the region of the vertebræ, but to the abdomen or thighs. This is often pronounced at night as a result of involuntary muscular movement.

Upon examination of the spine an impaired mobility is at once detected, and constitutes a most important diagnostic feature. The *stiffness* is produced by reflex muscular spasm, and in part by an almost unconscious effort on the part of the patient to so adapt the position and movements of the body, as to insure the greatest possible protection to the spine. Thus attitudes are assumed which produce a change in

the habitual appearance of the patient. There is an evident disinclination to walk, with pronounced indications of physical weakness. The child frequently refuses to stand without support, and if compelled to walk, does so with slight flexion of the knees, careful tiptoeing steps, and with the arms partly outstretched in front, as if in silent appeal for immediate support.

Tests to determine the flexibility of the spine demonstrate, in addition to the stiffness, the peculiar awkward attitude already mentioned, and changes in the contour of the spinal curves. The abnormal outline and diminished flexibility are detected when the patient is forced to assume an anterior bending position. By means of this test a limitation of motion of a particular portion of the spine is found to take the place of a sweeping regular curve. The ability to stoop in a natural way to pick something from the floor is also materially diminished. In whatever method the child undertakes to seize the object upon the floor it is noticed that the spine is almost invariably held without flexion, this attitude being particularly pronounced in involvement of the lower region. In such cases the child stands in an unusually erect position, with a beginning tendency toward lumbar lordosis. A slight unilateral limp may be noted as a result of psoas contraction from beginning abscess formation. This condition may be suspected if unilateral extension of the thigh is considerably restricted. The child is held prone upon the table, and effort made to raise the leg with the pelvis immobilized by the hand of the examiner. The search for pelvic abscess, though important, does not possess, from the standpoint of early diagnosis, the significance of the other signs already enumerated, as many months usually elapse before its presence can be detected.

Caries of the dorsal region of the spine is not especially different in many of its clinical features from that of the lumbar portion, the described characteristics of tuberculosis of the lumbar vertebræ being found, in the majority of instances, to obtain with but slight modifications in the dorsal portion. In the event of involvement of the upper dorsal region the body is inclined somewhat forward, the head thrown back, the shoulders elevated, and the general attitude that of marked debility. A tendency toward the so-called pigeon-breast is sometimes noted. Slight catarrhal irritation of the bronchial tubes, as evidenced by varying degrees of cough, often coëxists in these cases. The respiration is occasionally of a grunting character, particularly if the child is fatigued. Abscess formation in the neighborhood of the diseased vertebra may be detected by the physical signs.

Tuberculosis of the cervical region is usually attended by a peculiar stiffness in the neck. The head is often inclined to one side, but may be held in the median line in some cases. An evident disinclination is noted to rotate the head from side to side. Either the eyes are turned with the head immobilized in a fixed position, or the entire body is turned. In older patients the chin is sometimes supported by the hands.

Without reporting further diagnostic features inappropriate in this connection, it is sufficient to reiterate that in the majority of cases the warrantable data for the establishment of at least a provisional diagnosis are ample before the recognition of visible deformity. This is illustrated by an instructive experience with an important case some ten years ago. The child was between two and three years of age when the mother

noticed a disinclination to walk or stand, which she attributed to general weakness. After some weeks the head became inclined to one side and was persistently held in that position. The shoulders became slightly elevated, the chin depressed, with absence of rotation of the head. The awkwardness and gait of the child were characteristic. The knees were flexed, and when compelled to walk, the hands were invariably outstretched. The parents were disinclined to accept a diagnosis of spinal caries, and a fateful period of delay was maintained for seven or eight months, during which time a most unfortunate deformity developed both in the cervical and upper dorsal regions.

In striking contrast to the preceding, attention is directed to a case of caries of the spine in an individual with arrested pulmonary and intestinal tuberculosis coëxistent with parenchymatous nephritis. Fol-

Fig. 115.—Case of sacral and lumbar caries in a patient with advanced pulmonary tuberculosis. (Compare with radiograph, Fig. 116.)

lowing a period of one year's complete arrest of all tuberculous processes, as far as could be determined, there developed a degenerative change in both kidneys, followed in a few weeks by sudden severe pain in the lumbar region, more intensified upon the right side than upon the left. There were marked rigidity of the spine, slight tenderness in the neighborhood of the sacro-iliac articulation, inability to extend the leg upon the flexed thigh with the patient upon the back, and other characteristic evidences of spinal caries. Segregation of the urine showed both kidneys to be undergoing a parenchymatous change, with the process more advanced upon the right side. Repeated efforts to discover tubercle bacilli were unavailing. The question arose as to whether or not a tuberculous process in the right kidney might possibly constitute the immediate primary cause of the symptoms referable to the spine with a subsequent tuberculous involvement of the bodies of the vertebra. It

was finally decided by Drs. Baer, Packard, Powers, and myself that the original diagnosis of spinal caries was correct. There was no angular projection, and the skiagraph shows no deviation from normal contour of the spine.

Fig. 116.—Pott's disease of second and third lumbar vertebræ, causing scoliosis. Note high point at which sacral canal opens. (Compare with Fig. 115.)

Fig. 115 illustrates a pronounced deformity in a patient with sacral and lumbar caries and a discharging sinus, who came under my observation in January, 1907. His pulmonary disease had been of four years' standing, following an attack of appendicitis without operation. In May, 1906, after visiting various health resorts, he experienced marked

pain in the neighborhood of the left sacro-iliac articulation, with the subsequent development of a fluctuating tumor which was opened at once. The lower portion of the spinal column is seen to have undergone an abrupt curvature to the left. The accompanying skiagraph (Fig. 116) shows extensive necrosis of the sacrum with moderate involvement of the bodies of the second and third lumbar vertebræ.

The symptoms of **tuberculosis of the hip-joint** are almost always of very insidious onset, although they occasionally begin more or less

Fig. 117.—Tuberculous infection of the inferior part of the third lumbar vertebra. The diseased area is indicated by the arrow. Note dark shadow above arrow resulting from abscess formation. This patient died about one year subsequent to the time of this examination from tuberculous meningitis.

abruptly. The condition is recognized as an involvement of a single joint, thus affording a differentiation from rheumatism and other polyarticular affections. There is no invariable relation between the symptoms referable to the joint and the general condition, although many patients are observed to present indications of more or less physical debility. Fever is present in some instances, but possesses comparatively little diagnostic import.

The early symptoms are pain, lameness, and impaired mobility of the

joint, due to muscular spasm. Pain is by no means constant, and may be absent at any stage of the disease. There is no direct interdependence between the amount of pain and the extent of pathologic change involving the joint. It is sometimes absent despite an extensive destructive process involving the head of the femur, or even producing perforation of the acetabulum. If there is an acute ostitis, however, the pain may be very intense. Often it is more pronounced during sleep, and gives rise to the production of night-cries, which have been described. The pain during the night is produced by spasmodic contractions following relaxation of the muscles, which, during waking hours, have served to protect the sensitive joint. The child does not always awake, but if aroused, rarely complains of pain or bad dreams, and does not exhibit evidences

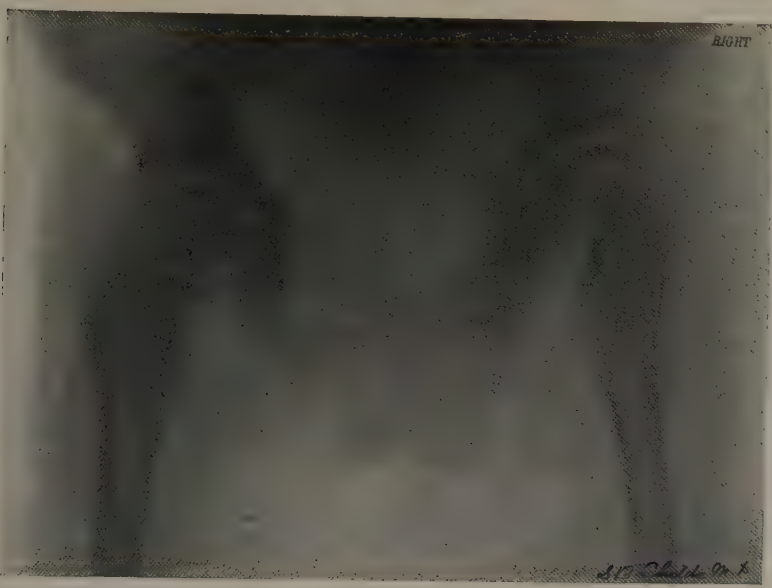


Fig. 118.—Incipient tuberculosis of both hip-joints. The disease is indicated by slight irregularity in the upper part of the rim of the acetabulum and by characteristic cloudiness about each joint. Clinical symptoms of the disease were present in the right hip-joint at the time of taking the skiagraph, but were not marked in the left until about two months later. The disease in this case evidently originated in the right hip-joint, as evidenced both by the clinical symptoms and by the greater amount of atrophy shown in the right femur.

of fright. In the early part of the disease there is but little admission of local pain or sensitiveness to pressure. As the affection advances, however, these symptoms may become pronounced to a considerable extent. The pain is usually referred to the knee, and is aggravated upon jarring or manipulating the limb. Varying degrees of remission of pain may take place. Lameness is of much more importance, even as an early symptom of hip-joint disease, than pain. The limp is more or less characteristic, the patient being observed to favor the joint as much as possible upon walking. There is a noticeable stiffness or irregularity of gait, with diminution in the length of the step and a distinct favoring of the affected joint. The weight is borne upon the ball of the foot rather than the heel, and is speedily transferred to the other foot. In some cases there is a tendency toward flexion at the ankle as well as at the

knee and hip. The limp is more pronounced in the morning or after a period of rest. Impaired mobility of the joint is a constant feature of the disease. The degree of muscular rigidity is subject to great variation, but a certain limitation of motion is present in all cases.

Manipulation of the joint is often accompanied by pain, especially when an effort is made to move the limb to the full limit of normal mobility. Motion of the joint is found unrestricted throughout the range of a certain arc, but abruptly checked by muscular resistance beyond the limits. The degree of muscular fixation affords an approximate idea of the progress and course of the disease, and varies directly with the sensitiveness of the involved area. Another result of the reflex spasm is the frequent distorted position of the limb, which may appear

Fig. 119.—Incipient tuberculosis of the right acetabulum. The head of the femur is drawn markedly upward and outward as a result of muscle contraction. Contrast the position of the head of the right femur in the acetabulum with that of the left. Note characteristic atrophy of the right femur.

to be either lengthened or shortened. The apparent lengthening is produced by abduction and outward rotation. This attitude is frequently assumed in early cases upon standing, and is attended by a downward and forward tilting of the pelvis.

An instinctive effort is made to insure protection and support to the affected joint by resting the lower part of the leg of the affected side upon the foot of the sound limb, so guarding its movements as to avoid shock or jar. Upon walking, the direct impact of the femur upon the acetabulum is lessened by the spring-like action of the flexed ankle-, knee-, and hip-joints.

The characteristic position of the limb represents an unconscious effort to diminish as much as possible the function of the joint in supporting the weight of the superincumbent body. The appearance of length-

ening of the affected limb, for which compensation is afforded by tilting of the pelvis, varies with the degree of abduction, which is usually associated with outward rotation.

An appearance of shortening is produced by flexion and abduction with inward rotation, which position in more advanced cases is voluntarily assumed upon walking. This is accompanied by an upward tilting of the affected side. When the limb is apparently lengthened, the fold between the thigh and gluteal fat is lower than its fellow of the opposite side, and is less pronounced on account of the flexion of the thigh. When the limb presents the appearance of shortening, the gluteal fold is higher and shallower than upon the unaffected side, while

Fig. 120.—Tuberculous infection of the left acetabulum. The disease is indicated in the skiagraph by the lighter shadows which are seen in the upper part of the acetabulum. Note the atrophy that has taken place in the left femur. This skiagraph shows the disease a little farther advanced than is represented in Figs. 118 and 119.

in front the vulva is elevated and the inguinal fold is deepened and lengthened.

Atrophic changes in the muscles of the affected limb are almost constant, and are especially pronounced in the thigh and gluteal region. The atrophy takes place surprisingly early.

Suppuration may occur both within and without the joint, and give rise to external evidences of abscess formation, pus often presenting in the anterior and lateral regions of the thigh.

Late in the course of hip-joint disease actual shortening of the limb may take place. This condition, however, is of comparatively slight importance in diagnosis on account of its delayed manifestation.

In Figs. 118 to 124 inclusive are shown the serial stages of hip-joint disease from incipiency to recovery as disclosed by the *x*-ray.

The technic of physical examination, the methods of ascertaining the various measurements, and the details of differential diagnosis of hip-disease, perhaps more than any other tuberculous joint lesion, belong strictly within the domain of orthopedic surgery.

The symptoms of **tuberculosis of the knee-joint** conform in their essential characteristics to the general description of tuberculous joint lesions mentioned on p. 445. Attention was directed to local swell-

Fig. 121.—Active tuberculous disease of the left hip-joint. The head of the femur has been almost entirely absorbed. A drainage tube is shown *in situ*. There was a discharge of a pint of pus from the joint daily at the time of the examination.

ing, tenderness, pain, circumscribed temperature elevations, infiltration of tissues, limitation of motion and flexion. These changes afford a fairly accurate characterization of the symptoms of knee-joint tuberculosis. Lameness is usually present, the limp varying with the intensity of the inflammatory and destructive process. The swelling is produced by the pathologic changes in the neighborhood of the joint, in the synovial membrane itself, and by the presence of moderate effusion between the articular surfaces. Motion is limited, and flexion is invari-

Fig. 122.—Well-marked tuberculosis involving the left acetabulum and head of the left femur. The disease in this case has persisted for three years, but at present the process of repair is becoming established. Note the characteristic atrophy of the left femur.

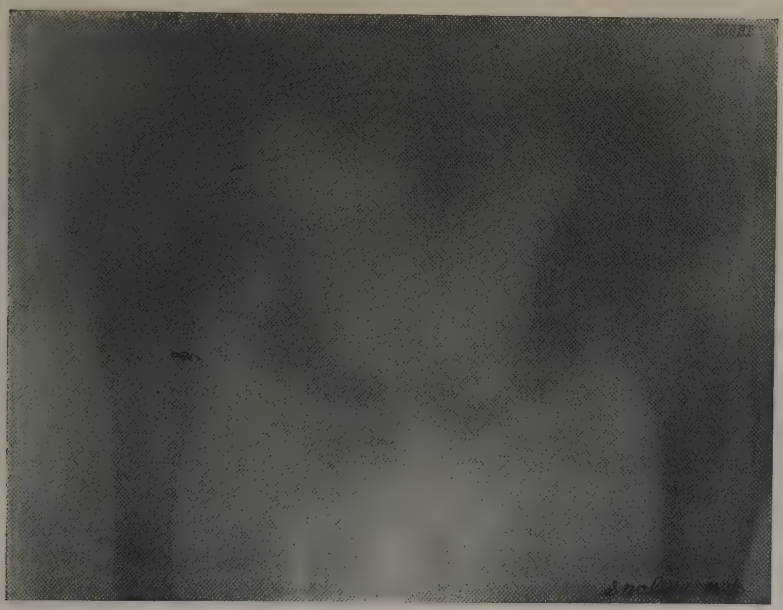


Fig. 123.—Old tuberculous infection of the left hip-joint. The patient now has fairly good use of the leg, the disease having been arrested. The head and part of the neck of the femur have been absorbed and the remnant of the neck is dislocated backward. The lesions in the acetabulum are well shown. Note the characteristic atrophy of the left femur.

ably present, as well as reflex spasm of the muscles. The degree of flexion corresponds largely to the acuteness of the infection. Other deformities of a secondary character may take place. The various

Fig. 124.—Complete recovery from an extensive tuberculous infection of the right hip-joint in infancy. The skiagraph shows that the head of the femur has been absorbed. Firm bony union has taken place between the thickened neck and the acetabulum, permitting no movement at this joint but the patient has a useful limb.

displacements of the tibia upon the femur with certain other deformities are late manifestations of the condition, and do not require more than mention of their occasional existence in such cases.

CHAPTER LXV

TREATMENT OF TUBERCULOSIS OF BONES AND JOINTS

It is possible to consider but briefly the principles upon which is based the management of tuberculous bones and joints. Obviously, no attempt can be made to discuss special methods of treatment, particular mechanical contrivances, or other technical features.

The treatment consists, first, of general hygienic management, and, secondly, local measures, which may be non-operative or purely surgical.

General Hygienic Management.—The hygienic treatment of tuberculosis of bones and joints is identical with that of tuberculosis of the lymphatic glands, to which attention has been directed. It is important to emphasize again the inestimable value of an out-of-door existence, combined with a suitable environment at the seashore, the country, or the mountains. It is possible that the wonderful advantages accruing from the application of these principles of treatment are more conspicuous in bone and joint tuberculosis than in cases of glandular involvement. Greater recognition is being accorded by surgeons to the benefits resulting from improved nutrition and increased individual resistance. By this means direct surgical interference is often avoided entirely, whereas in other cases such intervention is permitted to take place at a time when the general vitality and condition of the tissues are such as to insure not only a more rapid healing, but to lessen materially the likelihood of further tuberculous dissemination. In the event of moderate fibrous tissue proliferation about a tuberculous focus, operative surgery is attended with much less danger of general tuberculous infection than when fresh open surfaces are brought directly in contact with infective material. The process of repair in such cases consists essentially of the inclosure or incapsulation of the tuberculous focus by a barrier of protective connective tissue. Absorption, as well as elimination through abscess formation, at times plays an important part in an arrest of the disease, but the formation of granulation tissue in the periphery of the diseased area, and its subsequent organization resulting in dense fibrous tissue development constitutes nature's constructive efforts toward the arrest of the tuberculous lesion. It must be remembered that the condition is *tuberculosis* presenting the same features of pathology as the pulmonary affection, exhibiting, it is true, distinct differences in type, but, nevertheless, subject to the same principles, and affording similar indications in the way of therapeutic management. The reparative processes are accelerated directly in proportion to the increased general vitality and the local resistance of the tissues. The essential consideration, therefore, in all cases is the primary effort to fortify the general condition by a conscientious and sometimes radical application of the principles of nutrition and hygiene. Life in the open air, with an abundance of nutritious food and opportunity for recreation, increases the reparative forces to an extent unequaled by any other therapeutic agent.

In those cases in which the articular surface of the joint is not seriously involved, although an intact cartilage may be found to conceal an extensive destructive process in the bone, general hygienic

management alone is sometimes sufficient to bring about an ultimate quiescence, if not arrest, of the tuberculous process. Even in cases in which the joint is involved to such an extent as to preclude the control of the disease and to necessitate active surgical intervention there may be afforded, through a period of rest in the open air, with enforced nutrition, a heightened soil resistance and a suitable preparation for the surgical ordeal. The importance of the constitutional treatment, therefore, can scarcely be exaggerated, and equals in many instances the efficiency of all local measures of treatment, including the various forms of apparatus.

The value of the general régime, aside from the immediate environment and other features of management, is dependent upon the amount of sunshine and the number of hours in the day that the patient is permitted to remain in the open air. As stated in connection with the hygienic treatment of glandular tuberculosis, there is a conflict of opinion in regard to the relative advantages of the sea, country, or mountain air. It is apparent that the sea-coast sanatoria upon the shores of the Mediterranean or the Adriatic are hardly suitable for comparison at all times of the year with resorts upon the Atlantic coast, on account of differing weather conditions. If the good effects in various locations are produced to any extent by the amount of sunshine and other climatic conditions affording an outdoor existence, it is reasonable to believe that the very best results can be obtained in those regions permitting the most complete elaboration of the principles upon which depend the efficiency of the treatment. Judged by this token alone, the climate of the eastern Rocky Mountain slope offers opportunities for improvement from bone and joint tuberculosis unsurpassed in any other section of the country. The every-day experience of clinicians in Colorado affords convincing proof of the truth of this assertion. The consensus of opinion among general and orthopedic surgeons, as well as internists, is to the effect that, in spite of the peculiar hereditary predisposition on the part of a large portion of our infant population, tuberculous bone and joint lesions are remarkably rare. There is, beyond question, decidedly less tendency toward suppuration and active symptoms than is reported to exist in other regions. Actual experience has demonstrated a shorter duration of the disease in Colorado and, as a rule, the attainment of better functional results. The details of an open-air régime, either within or without sanatoria, will be reserved for the Treatment of Pulmonary Tuberculosis.

General medicinal measures are of but slight avail, though tonics and nutrients are sometimes indicated by an anemic, impoverished condition. The administration of the bacilli emulsion of Koch is now recognized to be of undoubted value for many of these cases, and promises to constitute one of the exceedingly important features of treatment.

The **local management** of tuberculous joint lesions includes nonoperative measures and active surgical intervention. The choice between these two general methods of procedure depends upon essential differences in the type of the disease, its acuteness, the extent of destructive change, location, impairment of function, presence of suppuration, especially if associated with secondary infection, the danger to life, existence of tuberculous foci in other parts of the body, and the age of the patient. The decision should rest not solely upon the consideration

of a single factor, but rather upon a review of all the clinical features. It is essential that a well-sustained estimate be made of their bearing upon the life of the individual and the preservation of function. It is clearly the duty of the surgeon to be prepared to employ all rational measures with a wise discrimination according to widely varying conditions, to the end that life may be saved without unnecessary mutilation. Treatment along the lines of conservative surgery has been productive of highly gratifying results, save in those instances demanding immediate operative interference upon the basis of certain clinical or pathologic data. In the latter event mechanical contrivances are as much out of place as amputation would be in favorable cases. When the exigency exists, however, there should be no hesitation even in sacrificing a limb in order to preserve life.

In general, it may be stated that in children with tuberculous bones and joints the field of operative surgery is comparatively limited. At this age the lymphatic spaces are more permeable and there is greater danger of dissemination of the disease. This is particularly true if operations are performed before opportunity is afforded for abundant fibrous tissue formation about a tuberculous area. Fibrosis takes place much more quickly among children than adults, on account of the rapidly forming granulation tissue in early life. Thus the process of repair is often sufficient in the very young to insure such a degree of arrest of the tuberculous process as would be impossible in later life. At the same time, after growth has been attained, excision of a tuberculous area does not involve the loss of as wide a portion of healthy bone as is true in the growing tissues of children.

Nichols has shown that there is an undoubted tuberculous infection of bone, at least an inch beyond the limits of its macroscopic appearance, thus suggesting the expediency of removing a considerable portion of apparently unaffected bone whenever excision is practised. Such a procedure, unfortunately, involves a site of operation outside the protective barriers of fibrous tissue formation, and does away at once with the advantages derived from this source, to which allusion has been made. Again, it is questionable if it is always advisable to attempt the complete removal of infected tissues. As a matter of fact, the operation is often more or less incomplete at best, though attended by excellent results, thus suggesting the important rôle of the natural reparative forces. Therefore, operations upon children, in whom the constructive efforts toward arrest are most pronounced, are to be avoided on account of the unnecessary sacrifice of healthy bone and the greater likelihood of further extension of the process. In this connection it is well to call attention to the fact that in nearly all cases the bone lesion is secondary to other foci in the lymphatic glands. The removal of the secondary focus is not followed by a complete restoration of health unless the surgical treatment is accompanied by so complete an elaboration of the principles of hygienic management as to insure the incapsulation of the primary seat of disease. In adults the primary focus is more likely to be quiescent, if not entirely arrested, and the extirpation, therefore, of the local secondary lesion, even of long standing, is less apt to be followed by renewed infection than in early life. Conservative measures, then, are to be employed in children whenever not positively contraindicated.

Local non-operative procedures consist of the application of such varying forms of apparatus as will enforce rest and secure a degree

of fixation and extension. As far as the local treatment is concerned, these three conditions constitute the essential desiderata in an effort to arrest the tuberculous process. Thus protection is also afforded against further injury, and suppuration rendered less likely. The ultimate preservation of the function of the joint is rendered more probable as the local irritation diminishes. Fixation of the joint, with complete rest and traction, not only lessens the joint pressure, but relieves pain and muscular spasm.

Goldthwait differs from the majority of orthopedic surgeons in believing that the joint should not be absolutely confined. He favors merely a limitation of function rather than complete fixation. He limits the motion of the joint only to such an extent as will control the symptoms, and permits the use of the joint up to the point of toleration, believing that by this means there results less disturbance of the circulation and nutrition. In other words, he regards the principles of treatment of tuberculous joint lesions as closely analogous to, if not identical with, those involved in the management of pulmonary tuberculosis. He takes the position that the respiratory function in the latter cases should be in no way restricted, and in order still further to increase respiratory effort, he advocates considerable activity in high altitudes, combined with special exercises along the lines of pulmonary gymnastics. His conclusion as to the wisdom of retaining a limited function of affected joints is entitled to an appreciative consideration, for his views are based upon an experience sufficient to carry conviction as to the accuracy of his opinion. The principles of treatment of the pulmonary involvement, however, as regards exercise, should not be accepted as belonging to the same category with those applicable to affected joints. In one case the condition is purely local, not directly involving the preservation of life, and subject almost entirely to mechanical principles. In the other, the vital organs affected are constantly performing the function necessary for the continuance of life.

Nearly all orthopedic surgeons agree that after the acute stage has been passed, with extension in the recumbent position, limited motion may be cautiously permitted, provided the diseased joint is protected from bearing the weight of the body. It is manifestly impossible to discuss the relative merits of the various methods of securing rest, fixation, and extension for the tuberculous joint, or to enter into a consideration of the numerous special appliances, all of which aim to afford as much protection as possible to the joint. The purely technical consideration of mechanical contrivances is strictly within the province of the orthopedic surgeon.

In contradistinction to the employment of apparatus whose action is confined as far as possible to the restriction of motion, utilization is sometimes made of passive congestion without confinement of the joint. The so-called *Bier treatment of tuberculous joints* consists of the establishment, through mechanical means, of a localized passive congestion. The venous circulation is constricted by means of a rubber bandage above the affected joint, applied in such a manner as not to interfere with the arterial supply. In order to localize the congestion the limb is bandaged from its distal portion nearly to the lower part of the tuberculous joint. The principle of treatment is based upon the clinical fact that pulmonary tuberculosis is seldom observed in people suffering from passive congestion of the lungs incident to cardiac dis-

turbance. The venous congestion is believed to increase phagocytosis, stimulate absorption, diminish the activity of the disease, and accelerate the formation of fibrous tissue. Relief of pain and other beneficial results occasionally attend the employment of this method. It would seem that, if it be used at all in the treatment of joint tuberculosis, it should not be permitted to supplant entirely the protection afforded by rest and fixation of the joint.

The purely *surgical procedures* consist of amputation, excision of joint, erasion of bone, and the management of tuberculous abscess. Amputation is occasionally demanded in adults on account of complete or extensive destruction of bone and a greatly impaired general resistance. The sacrifice of the limb is especially indicated if, in spite of the best of food and surroundings, the general condition is shown to grow progressively worse.

Excision of the joint, which consists of the complete removal of the articular surface of the diseased bones, is not uncommonly practised in adults and sometimes in children. The indication for the operation is the known extensive destruction of the articulating surfaces, rendering the joint utterly hopeless and presenting, at the same time, a constant menace to the patient on account of the possibility of further tuberculous dissemination.

Erasion or the removal of a localized area of bone is sometimes possible without resorting to complete excision. It consists of the extirpation of diseased bone tissue by means of knife, gouge, curet, or scissors, followed by the free use of iodin, pure phenol, or alcohol, in order to avoid the danger of secondary infections or extension of the tuberculous disease.

The treatment of tuberculous abscesses should vary to some extent according to the evidences of general infection and the impairment of function. In case of considerable temperature elevation, with or without chilling, together with a deterioration in the general condition, incision and drainage should be performed with as thorough disinfection of the cavity as possible. If, however, the presence of the abscess occasions merely an interference of function without a general systemic infection, efforts toward the removal of the pus by repeated aspiration are to be employed before resorting to the open incision. Aspiration is preferable in such cases on account of the greatly lessened danger of extension of the disease, the avoidance of secondary infection and of general septicemia through contamination from a discharging sinus. The question of interference with closed tuberculous abscesses of bone or joint origin, without secondary infection or disturbance of function, remains more or less *sub judice*. Certain it is that in many cases the impracticability of a complete excision of the tuberculous area, the possibility of resulting sinuses, and the secondary infection afford strong arguments against precipitate surgical interference.

SECTION VI

TUBERCULOSIS OF THE ALIMENTARY TRACT

CHAPTER LXVI

ETIOLOGIC AND ANATOMIC FACTORS

TUBERCLE deposit may take place throughout the entire course of the digestive canal from the lips to the anus, although a very considerable difference is noted in the various parts as to the frequency of involvement. Inasmuch as the relative merits of the respiratory and digestive systems in offering a port of entry to the bacillus have been reviewed in detail, it is unnecessary, at this time, to discuss the alimentary canal as a channel of *initial* tuberculous infection. Attention is directed solely to the various sites of tubercle deposit along the *via naturales*, in connection with diverse etiologic factors of an anatomic or physiologic nature.

Tuberculous lesions of the buccal mucous membrane are exceedingly infrequent. In view of the passage of bacilli-laden sputum through the mouth of consumptives in the act of expectorating, it is apparent that, in addition to certain anatomic conditions producing a relative invulnerability of tissues, there must be present other considerations of a physiologic, chemic, and mechanic nature, in explanation of the rarity of local infection. The squamous epithelium of the buccal mucosa, in the absence of injury, is almost impermeable by the bacilli, in marked contrast to the columnar epithelium of the small intestine. Cornet has called attention to the thickening of the mucous membrane of the mouth by the continual mechanic friction induced by mastication.

It has been asserted by some observers that the infrequency of oral tuberculosis is due to the fact that infective material is seldom retained within the mouth, either being swallowed or expectorated without delay. This explanation would seem to be quite insufficient in view of the facilities for retention of microörganisms in the numerous recesses of the mouth. Bacilli have been found in decayed teeth, and there is no reason why they may not be present in the fold between the cheek and the gums. The removal of a carious tooth in a consumptive is occasionally followed in the course of some months by necrosis of the lower jaw, suggesting the possibility of an extension of the infection through the open extraction wound.

The mouth is known to contain a most luxuriant bacterial flora, representing many varieties of microörganisms. While the mouth and entire digestive tract of an infant at birth are absolutely sterile, there shortly appear in the stools colon bacilli, yeast-cells, and the bacillus lactis aërogenes. The belief in some quarters that the presence of these germs was even essential to life has been disproved by the experiments of Nuttall, who found guinea-pigs to thrive after the establishment and maintenance of a perfectly sterile condition of the alimentary canal for a considerable period. The mouth is, indeed, the habitat of innumerable germs of varying description, whose place of abode is

not necessarily confined to concealed recesses. It is likely that the action of these microörganisms upon the secretions within the mouth is such as to exert an inhibitive effect upon the development of the bacilli. It is not clear whether the influence opposed to local bacillary infection relates to the conversion of the normal alkaline saliva into an acid secretion by the presence of the various germs, or to the action of certain bactericidal properties of the mucus. With an unbroken continuity of the mucous membrane local infection is extremely infrequent, but the rarity of buccal tuberculosis may hardly be explained by a supposed absence of the infective agent.

The site of nearly all tuberculous lesions within the mouth is found in excoriations of the mucosa following previous injury or disease. Local mechanic irritation of the tongue arising from a sharp projecting tooth has been known to afford a lodging-place for tubercle bacilli among advanced consumptives. It has not been shown, however, that such irritants as alcohol and tobacco have an especial predisposing influence upon the development of the local condition.

The *tongue* is less frequently involved upon its upper or lower surfaces, the tip and lateral margins being the most common seat of the tubercle deposit. The process is usually quite superficial, consisting of infiltration or shallow ulcerations. The outline, as a rule, is irregular, and the edges are slightly beveled. Small yellowish-gray spots may be discerned here and there upon the reddish, granulating surface. There is but little surrounding induration, although after complete cicatrization this is sometimes noted. The *pain* and other subjective symptoms are, as a rule, comparatively slight, in contradistinction to the discomfort and suffering experienced in the event of tuberculous involvement of the soft palate, tonsils, and pharynx. Seldom is there found a secondary enlargement of the cervical glands.

Tuberculosis of the gums conforms in general to the type of lesions found upon the tongue and hard palate, the infection being, as a rule, relatively benign. While superficial lesions predominate, deep tuberculous ulceration occasionally takes place. Levy has recently shown a typical deep ulceration extending to a necrotic alveolar process, the diagnosis being confirmed by examination of the infected tissues, in which were found well-defined tubercles and few tubercle bacilli. He has also exhibited a series of very interesting tuberculous lesions, involving the hard palate, soft palate, and tonsils. Tuberculosis of the lips is very uncommon, and corresponds more or less to the slow benign variety of tuberculous lesions of the skin, *i. e.*, lupus vulgaris. Unlike tuberculous affections of the pharynx, soft palate, or tonsils, the lesions are possessed of but very slight importance, as they influence almost to no extent the general prognosis.

Tuberculosis of the soft palate and pharynx is relatively infrequent, but when present, constitutes a most distressing form of the disease. As a rule, the lesions are active and rapidly progressive, corresponding to a malignant type in contradistinction to the local processes involving the tongue, gums, hard palate, and lips. These are more frequently sluggish, and in many instances result from purely local infection. When the soft palate and pharynx are involved, a beginning pallor is usually observed, with or without a slight edematous swelling. With the thickening of the mucous membrane there may be noticed the appearance of small tubercles, which are seen as tiny yellowish-gray

spots. Ulceration soon takes place, attended with pain, which is especially severe upon deglutition.

The local condition is often an accompaniment or expression of a general miliary invasion. It may occur, however, in the later stages of pulmonary tuberculosis, when the strength of the patient is well-nigh exhausted, and the retention of sputum in the pharynx is favored by benumbed local sensibilities and diminished expulsive power. It must not be assumed, despite these unusual opportunities for local infection, that the tubercle deposit necessarily results from the inward penetration of the pharyngeal mucosa. Several times I have seen tuberculous ulceration of the soft palate and pharynx in strong and robust individuals exhibiting but very slight evidence of tuberculous infection in other parts of the body. Recently there has come under my observation a gentleman with but slight loss of weight and strength, but exhibiting well-defined tuberculous ulceration of the posterior wall of the pharynx, which developed long before pulmonary involvement was suspected. Examination of the chest disclosed the presence of a slight quiescent pulmonary infection unattended by expectoration.

Attention has been called to the frequency of *tonsillar infection* in pulmonary phthisis, and to the occasional presence of bacilli in the tonsils of individuals exhibiting no symptoms of tuberculous disease. The coëxistence of localized tonsillar tuberculosis in the midst of far-advanced pulmonary phthisis is sometimes demonstrable, but the rôle of the tonsil in constituting invariably an open pathway of infection to the cervical glands is subject to some question. Jacobi has recently called attention to certain clinical and anatomic facts which prejudice strongly the likelihood of frequent systemic invasion by way of the tonsil. He cites the comparatively few changes which take place in the cervical lymphatic glands in connection with inflammation of the tonsils, and assumes that a free communication between the tonsil and the system by way of the lymphatics is prevented by a dense fibrous structure intervening between the tonsillar tissue and the site of its implantation. He believes that, as a result of repeated acute and chronic inflammatory changes in the tonsil, the tissues in adult life are rendered less permeable to bacillary invasion than in infancy.

Although in advanced phthisis the conditions are such as to afford unusual opportunities for infection of tonsillar crypts, yet there may be no macroscopic evidences of tuberculous involvement. Genuine tubercle deposit may be recognized by very small grayish spots scattered here and there over a pale, edematous tonsil. Irregular ulcerative processes are sometimes present.

Tuberculosis of the esophagus is extremely rare, and takes place almost invariably as a result of extension from mediastinal glands. Even among consumptives addicted to the habit of swallowing their sputum the conditions are such as almost to preclude an involvement of the esophageal mucosa. The smooth stratified epithelium assuredly is not calculated to afford a lodging-place for bacilli swept downward with a bolus of infected food. At the same time individuals who have become so exhausted by the disease as involuntarily to swallow their sputum are almost sure to succumb to the pulmonary affection before the development of esophageal tuberculosis. It has been recorded, however, that tuberculous mediastinal glands have become acutely inflamed and adherent to the esophagus. These may later

undergo caseation and perforate the esophageal wall, presenting in some instances the symptoms of stenosis. Partial occlusion of the lumen may take place without perforation. It should be borne in mind that symptoms of constriction of the esophagus are sometimes present *without* the slightest *encroachment* upon the lumen, and that occasionally *actual stenosis* is *unattended* by subjective symptoms.

I recall two cases which illustrate both of these clinical phenomena, in each instance confirmation being afforded by autopsy. In one the patient died of intercurrent pneumonia, which developed after removal to the hospital for esophagotomy, following very pronounced symptoms of constriction during a period of a year or more. The autopsy, conducted by Dr. Axtell in the presence of Drs. Powers, Sewall, and myself, showed no pathologic change in the esophagus.

The other patient was sent to Colorado on account of a supposed tuberculosis. The clinical manifestations were marked emaciation and cough, in the absence of all symptoms referable to the esophagus. There was no expectoration, and the cough was decidedly paroxysmal and wheezy. Physical examination was negative, save for the recognition of sibilant râles throughout the lungs. The clinical picture suggested compression of the trachea, which was apparently confirmed by the fluoroscope. The patient expired after a few weeks from suffocation, and the autopsy disclosed the presence of an esophageal tumor, which, although not tuberculous, is worthy of mention as illustrating the lack of relation between the pathologic change in the esophageal wall and the subjective symptoms.

Kümmel has recently reported an extraordinary case of esophageal tuberculosis in a patient fifty-two years old, alcoholic, and suffering from pulmonary infection. Four-fifths of the entire esophagus was involved in the tuberculous ulceration, and yet no clinical symptoms were noted pointing to an affection of the esophagus.

Von Schrötter reports two cases of tuberculosis of the esophagus recently observed, in each instance the infection following a primary involvement of the right lung, with adhesion of the esophageal wall. The diagnosis was made by direct inspection of the lesions with the esophagoscope.

Tuberculosis of the stomach is exceedingly rare, and is possessed of but slight interest or clinical importance. It has resulted occasionally from the extension of peritoneal tuberculosis. The possibility of a tuberculous infection ingrafted upon the site of an open gastric or pyloric ulcer remains a somewhat disputed question. In general the conditions within the stomach inimical to the development of local tuberculosis are the dilution of the bacilli, the muscular movements, and the acid reaction of the gastric juice. In addition to these factors Barchasch calls attention to the scarcity of lymphatic follicles in the stomach-walls, and believes that important causes in the development of tuberculous lesions in the stomach relate to the increase of lymphoid follicles incident to chronic gastric catarrh. He suggests that, inasmuch as the pylorus is supplied with lymphoid tissue to a greater extent than other portions of the stomach, possibly stenosis of this region is tuberculous oftener than has been supposed. He calls attention to the tuberculous ulcer, the miliary tubercle, the solitary tubercle, and tumor-like masses in the stomach closely simulating carcinoma.

CHAPTER LXVII

TUBERCULOSIS OF THE INTESTINE

Allusion has been made in earlier pages to the results of pathologic research and experimental study, which demonstrate conclusively the importance of the digestive tract as a direct avenue for the primary invasion of the system by tubercle bacilli.

Local tuberculous processes in the intestinal wall, especially in adults, are secondary in the majority of instances to involvement of other parts. They undoubtedly take place in consumptives as the result of unusual local exposure to infection, with an added vulnerability of tissues induced by virtue of the original disease. Primary tubercle deposit in the intestine, though less infrequent than formerly supposed, is decidedly more rare than the secondary infection. Fürst has collected the histories of 160 authenticated cases of primary intestinal involvement. Many cases are reported by such authors as Demme, Baginsky, Epstein, Orth, Kossel, Lubarsch, Eisenhardt, Hermsdorf, Klemperer, Wyss, Ollivier, Ganghofner, and Herterich. Orth reports that, from a recent observation of 44 tuberculous children, primary intestinal tuberculosis was present in 10 per cent. of the cases. It has been shown that a considerable number of primary lesions of the intestine were caused by tubercle bacilli of the bovine type.

Bovaird has called attention to the lack of uniformity in the results reported by various observers regarding the prevalence of primary intestinal infection in tuberculous children who have come to autopsy. Among American observers, out of 369 autopsies, but 5, or 1⅓ per cent., disclosed a primary tuberculous deposit in the intestine. The Germans report 9 cases, or 4 per cent., out of 236 autopsies. From among 128 autopsies reported by the French there was no single instance of primary intestinal disease. The English, however, have observed 136 cases, or 18 per cent., out of 748 autopsies. After allowing for the apparent discrepancies in these reports, it may reasonably be inferred that primary tuberculous lesions of the intestine occur at most in but a small percentage of cases. The significance of the preceding statistics is enhanced by consideration of the fact that little children are exposed to the dangers of infected food to a far greater extent than adults, on account of the preponderance of milk as an article of diet, and the much greater delicacy of the intestinal structures.

On the other hand, tuberculous processes in the intestine are extremely frequent among individuals suffering from antecedent pulmonary involvement. In the Second Annual Report of the Henry Phipps Institute for the Study, Treatment, and Prevention of Tuberculosis White reports, out of a total of 143 autopsies upon consumptives, 45 cases exhibiting well-defined tubercle deposit in the small intestine, involving chiefly the ileum and the vicinity of the appendix. During the past year, out of 57 autopsies conducted, tuberculous ulcers were found in the jejunum in 7 cases, in the ileum in 32, and in 18 cases in which the location is not cited.

These results show a smaller percentage of tuberculous processes in the intestine than are reported by other observers. According to Cornet, Eichhorst found intestinal ulcers in 21.9 per cent. of 462 au-

topsies upon pulmonary invalids; Heinze, 51 per cent. in 1226 cases; Höning, in 70 per cent.; Weigert and Orth, in 90 per cent.; and Herxheimer, in 57 cases out of 58.

It is noteworthy that local processes in the intestine are far more common than in any other portion of the alimentary tract. Among the various causes which may be ascribed to explain the relative frequency of infection in this part of the digestive system are the anatomic structure of the epithelial mucosa, the increased absorptive capacity of the intestinal follicles, the absence of an acid medium supposed to be inhibitory to the activity of the bacilli, the lessened dilution of the microörganisms after the absorption of the assimilable contents thus permitting a closer and more continuous contact with the mucous membrane, the separation of the bacilli from the protective coating of mucus in the sputum with which it is clothed in its passage from the pharynx through the esophagus and stomach, and, finally, the opportunities afforded in certain parts of the intestine for the retention of microörganisms. A brief consideration seriatim of these factors will afford perhaps a plausible explanation of the preponderance of lesions in this portion of the alimentary tract.

Bacilli are enabled to penetrate the cylindric epithelium of the gut much more readily than the stratified pavement epithelium of the pharynx and esophagus or the epithelium of the stomach. Absorption takes place essentially from the follicles of the intestine, in which immediate situation the tubercle deposit more frequently occurs. The follicular structure is more apparent in the lower portion of the ileum; the Peyer's patches are the more common seat of tuberculous involvement.

It is well known that tubercle bacilli do not thrive in an acid medium, though their vitality is not destroyed by the hydrochloric acid of the stomach. The alkaline reaction of the intestinal contents, while perhaps not distinctly favorable for their growth, is without doubt less inimical to their activity than the secretions from the mouth or stomach.

Tubercle bacilli gain entrance to the digestive tract largely as a result of contaminated food and the swallowing of infected sputum by consumptives. If bacilli be conveyed at meal time into the alimentary tract, there is afforded sufficient dilution almost to preclude infection in the stomach or upper digestive canal. With the absorption, however, of the liquid portion of the intestinal contents, bacilli which do not enter the chyliferous ducts are relatively more abundant in the solid residue, and are brought into more immediate and prolonged contact with the mucosa.

In view of the comparative rarity of *primary* tuberculous processes in the intestine and the remarkable frequency of local lesions among consumptives, it is apparent that an important etiologic factor is the occasional introduction of tubercle bacilli into the alimentary tract with the sputum of pulmonary invalids. Upon entrance to the digestive canal there is often such an admixture of tenacious mucus as to encompass effectually the opaque, semicaseous masses of sputum in which the microorganisms lurk in great abundance. As a result of the various digestive processes, the protective coating of bronchial mucus is finally separated from that portion of the sputum containing bacilli. Prolonged contact with the intestinal wall is thus permitted, especially in the region of the appendix, and the longer the stay of the microörganism at a given

point within the intestinal canal, the greater the likelihood of local infection.

Other pockets for the lodgment of tubercle bacilli are found in the little diverticula of the mucous membrane in the lower portion of the rectum, especially just above the anus. These are often of considerable depth, and imbedded to some extent in connective tissue. Slight traumatism, which not infrequently results upon a small scale from the hardened and inspissated feces, facilitates the colonization and invasion of bacilli. Further, the openings of the tiny lacunæ may become contracted more or less in an analogous manner to the occlusion of the proximal end of the appendix, giving rise to similar inflammatory changes. Thus may be explained the development of suppurative processes in this region resulting in the production of anal fistula. Bacilli are frequently demonstrated in the discharge, but it has not been shown that over one-half the cases of rectal fistula are positively tuberculous in character. The affection is not uncommon in pulmonary invalids, but it is doubtful if a large percentage of the patients can be shown to be definitely tuberculous.

The distinct **pathologic features** pertaining to tuberculous lesions of the intestine, aside from their location, relate either to the ulceration of the nodules, or to the thickening of the intestinal wall as a result of fibrous tissue proliferation after the manner of the pleura and peritoneum. *Two distinct types* of intestinal tuberculosis, therefore, are recognized—the *ulcerative* and the *hyperplastic*.

Irrespective of the nature of the tuberculous change the part chiefly involved is the cecum and its immediate neighborhood. Either form of the disease, however, may extend upward into the intestinal tract, involving the jejunum and duodenum, or downward into the ascending, transverse, or descending colon, and even affect the sigmoid flexure and rectum. Fenwick and Dodwell report that out of a total of 883 cases of tuberculous involvement of the intestine observed at autopsies performed upon 20,000 individuals dying of tuberculosis in the Brompton Hospital for Consumption, ulceration of the intestine was found in 500 cases, or 56.6 per cent. The ileocecal region was the seat of the disease in 85 per cent. of these cases, and in nearly 10 per cent. the tuberculous infection was confined to this region. In 28 per cent. of the cases there was involvement of the jejunum, in 3.4 per cent. of the duodenum, in 51.4 per cent. of the ascending colon, in 21 per cent. of the descending colon, in 13.5 per cent. of the sigmoid flexure, and in 14.1 per cent. of the rectum. It is sometimes possible to demonstrate visually the existence of tuberculous ulcers in the rectum, from four to eight inches from the anus, by means of the proctoscope and reflected light with the patient in the knee-chest position. In one patient the ulcers in this region were treated locally for a considerable period by Dr. Jayne and myself without, however, very satisfactory results.

Ulcerative Type.—The intestinal ulcerations vary in size, shape, depth, and in their disposal upon the wall of the gut. The erosion is sometimes superficial in character, extending merely to the submucous tissue, and at other times involves the entire wall of the intestine and even perforates into the peritoneal cavity. The size varies from a minute point of ulceration in the center of a nodule covered with epithelium, to a discrete, fairly circular erosion, which occasionally assumes the dimensions of a large bean or a dime. Even larger size may some-

times be attained by the coalescence of several individual areas of ulceration, in which event the outline becomes very irregular. The shape of discrete ulcerations, as a rule, is round or oval, but not infrequently the lesion becomes elongated and is disposed around the wall of the bowel, the long axis being transverse to that of the intestine. The borders of the ulcer may be infiltrated or exhibit overhanging edges. The floor presents a more or less characteristic grayish appearance, and is sometimes studded with small nodules, with at times slightly reddish projections. Cicatrization of tuberculous ulcers is not frequent, but takes place occasionally, instances of intestinal stenosis confirmed by autopsy being reported from this cause.

The **hyperplastic form** of intestinal tuberculosis is characterized by extensive connective-tissue formation, producing at times an enormous thickening in the wall of the bowel, which is usually more or less localized. Prior to 1891 occasional instances of intestinal tuberculosis were reported, in some cases there being a definable tumor and in others a stricture of the bowel. A genuine hyperplastic type of tuberculosis of the intestine was not recognized until Hartman and Pilliet described the condition in detail. Eight or nine years later Lartigau and Motel presented a histologic record of cases reported by various observers. Nancrede has recently published an illustrative case coming under his observation, and has reviewed at some length the literature pertaining to the subject. Fairly numerous cases have been reported, exemplifying in their description the conspicuous feature of fibrous tissue hyperplasia resulting from local tuberculous infection. This form of intestinal tuberculosis is associated at times with a varying degree of stenosis of the bowel. The indurated condition may be confined to a circumscribed region, usually in the neighborhood of the cecum, but occasionally extensive areas of the intestinal wall are involved. A considerable dilatation of the bowel may exist above the seat of the obstruction. This may be followed by a compensatory hypertrophy of the wall in an effort to overcome the initial occlusion. As a result of localized hyperplastic change a distinctly palpable tumor is sometimes recognized, giving rise to errors of diagnosis on account of confusion with carcinomatous and syphilitic neoplasms. I recall a single instance of this hyperplastic type of localized intestinal tuberculosis occurring in conjunction with similar processes in the peritoneum. The obstruction of the bowel was located in the region of the sigmoid flexure, but the precise nature of the condition was not established until the time of operation, the patient being under the observation of Drs. Bagot, Craig, Powers, and myself.

Hartman calls attention to the fact that these tuberculous hyperplastic processes resemble closely in aspect and evolution syphilitic changes in the bowel.

Baum has recently reported seven cases of ileocecal tuberculosis treated by operation, and describes the pathologic condition to be a benign hyperplastic form of primary tuberculosis, the macroscopic appearance of which resembles the hypertrophic form of lupus, with tubercle bacilli relatively infrequent. It is probable, as stated previously, that these apparently benign primary cases are often produced by the bovine bacillus, but it must not be assumed that all cases of hyperplastic intestinal tuberculosis are of benign character. Quite to the contrary, it is found that in the majority of instances they are

possessed of the greatest ultimate significance. To be sure, the development is often slow and insidious, without appearance of definite symptoms, but the hyperplastic growth relentlessly increases in size, and without operation eventually results in a fatal termination. The clinical onset is sometimes acute, and closely simulates the classic reaction exhibited in appendicitis. This was true to a marked extent in the case previously cited, and also in a conspicuous instance of hyperplastic involvement of the appendix, to be reported presently.

The practical interest regarding *ulcerative* tuberculous processes of the intestine among consumptives relates principally to the frequent digestive disturbances and the unfortunate effect upon the general condition.

The chief clinical manifestations of the non-acute type of *hyperplastic* involvement are the symptoms of gradually increasing intestinal obstruction and the existence of a discoverable tumor upon palpation.

Treatment.—Tuberculosis of the bowel, regardless of the particular type of the disease, is frequently amenable to surgical management. Several times it has been pointed out that in the presence of tuberculous processes involving the gut, the intestine tolerates radical surgical interference to a far greater extent than in the midst of other pathologic conditions. McArthur has called attention to the practice of excision or exclusion in these conditions, and reports five cases of extensive tuberculous involvement which have resulted in prompt recovery following operation. His views coincide with those of Baum as to the expediency of resection whenever the conditions permit its performance. This is more applicable, as a rule, to the hyperplastic type than to the ulcerative, on account of the more circumscribed area of the involvement and the more favorable condition of the patient. This method of surgical procedure, however, is permissible even in the ulcerative variety, provided too great an area is not diseased and the exhaustion with loss of nutrition not excessive.

The simpler method of exclusion or intestinal anastomosis may be practised when the extent of the disease and the debility of the patient would preclude the major operation. Hartman reports, from a review of the literature, 229 operative cases with 46 deaths.

By means of intestinal anastomosis following a fresh implantation of the unaffected portions of the bowel very extensive parts of the intestine may be excluded, with relief of previous distressing symptoms in individuals incapable of withstanding the shock incident to the performance of excision. It is remarkable, however, to what extent portions of the bowel may be resected successfully, even in patients exhibiting evidences of marked exhaustion. A case in point is that of an individual to whom I urged resection of the bowel in 1898. Despite a loss of over 60 pounds, together with much prostration, six inches of the ileum, the cecum, all of the ascending colon, two-thirds of the transverse colon, and most of the omentum were removed by Dr. Rogers, followed by complete recovery.

CHAPTER LXVIII

TUBERCULOSIS OF THE APPENDIX

Tuberculosis of the appendix has been shown by autopsy observations to be a frequent condition among advanced pulmonary invalids. In a series of autopsies conducted upon consumptives at the Phipps Institute tuberculous ulcers of the appendix were found in 44 out of 143 cases, but this proportion of about one to three must not be regarded as a fair basis upon which to compute its general frequency among pulmonary invalids as a class. It must be remembered that the condition of the appendix among individuals dying of far-advanced phthisis affords, for the purposes of comparison, no accurate data upon which to base conclusions relative to the frequency of similar involvement in patients exhibiting less extensive pulmonary infection. In the one instance the victim, after a more or less prolonged illness, has succumbed to an advancing infection following greatly diminished individual resistance and with exceptional opportunities for invasion of intestinal tissues. In the other, the essential consideration relates to the fact that the patient is still alive and maintaining, with varying success, the struggle to promote an arrest of the activity of the tuberculous processes, other tissues frequently becoming resistant to attack. Necropsy reports with reference to tuberculosis of the appendix, therefore, may be regarded, from a clinical standpoint, as more or less negligible quantities.

Ample means are undoubtedly offered for a protracted sojourn of tubercle bacilli in the blind appendiceal pouch, even to a greater extent than in the cecum. If, in addition to the indeterminate retention of the bacilli in the appendix, one considers the various influences leading to erosions and the other inflammatory and degenerative changes, it is easy to appreciate the favorable conditions afforded for the development of tuberculous ulcers.

Great practical importance attaches to the surgical findings at the time of operation and the character of previous manifestations. Tuberculosis of the appendix, as of the intestine, has been found to exist in two distinct types—the *ulcerative* and the *hyperplastic*. The former is much more common, and usually occurs in association with tuberculous lesions of the intestine, while the latter variety is relatively infrequent and characterized by an extensive connective-tissue hypertrophy. In either type of appendicular tuberculosis the process is in many instances coëxistent with ileocecal disease. It is often impossible to assert, from the surgical or pathologic data, whether or not the tuberculous process developed simultaneously with the intestinal lesions. While the disease of the appendix is usually coëval with a corresponding affection of the cecum, it has been shown that the process may occasionally be *limited* to the *appendix*, but very *rarely occurs* in the *cecum* without *appendicular involvement*. In Fenwick and Dodwell's report regarding the site of tuberculosis of the intestine, to which allusion has been made, it is stated that the appendix was found diseased in nearly every instance of ileocecal infection, which comprised 85 per cent. of the cases. In seventeen instances the appendix was the only portion exhibiting evidence of tuberculous change.

Primary tuberculosis of the appendix without discoverable lesion of the intestine or other parts of the body is extremely infrequent. Deaver doubts if any perfectly authenticated case has ever been reported. Kelly described six cases of primary appendiceal tuberculosis, one of which occurred under his own observation, the others being reported by Cullen, Sonnenberg, Henrotin, Crowden, McCosh, and Hawkes. He assumes the condition to be primary in character, because the clinical evidences pointed strongly in this direction, and asserts a confirmation of this belief by the fact that the removal of the appendix was followed by recovery. In *no instance* was the *tuberculous character* of the *appendiceal involvement suspected* until the specimen was subjected to *routine histologic examination.* This latter fact, in connection with present knowledge concerning the latency of tuberculosis and the imprisonment of the bacilli within tissues and organs presenting no abnormal macroscopic appearance, would seem to constitute in itself insufficient evidence to justify positive conclusions as to the primary form of the appendicular affection.

Failure to discover definite evidence of tubercle deposit in *any* portion of the body upon postmortem examination scarcely warrants the absolute exclusion of a concealed tuberculous infection, particularly in glandular tissues. If the absence of autopsy findings does not always justify the elimination of a possible tuberculous focus in a remote portion of the body, still greater difficulties must attend the exclusion of such infection solely upon the basis of the clinical evidences during life. Further, the mere recovery of the patient after operation affords an insufficient basis for the assumption of a primary lesion of the appendix. This course of remark is not intended to reflect in the least upon the possibility of primary tuberculous involvement of this region, but rather to suggest the insufficiency of the data upon which such views are necessarily based. As a matter of fact, the infrequency of primary infection of the appendix appears somewhat remarkable in view of the fact that the anatomic conditions particularly favor the development of tuberculous processes at this point in preference to any other portion of the intestinal tract. Assuming the introduction of bacilli into the digestive canal, the appendix should afford the most natural site for infection, on account of the retention of its contents and the receptivity of soil induced by frequent inflammatory and degenerative changes. That instances of supposed primary tuberculosis of this portion of the intestine are not more frequently reported is explainable by the non-appearance of macroscopic change and the absence of histologic examination.

In very many cases there is no distinguishing characteristic of tuberculous infection to be recognized upon visual examination, the condition apparently conforming to the various types of inflammation. In some instances, however, the detection of the nature of the involvement is rendered easy by the presence of small tuberculous nodules upon the peritoneal covering.

In the *ulcerative* type small caseous erosions may be found upon opening the appendix, the point of ulceration conforming to the general characteristics of tuberculous ulcers of the intestine as regards shape, contour, depth, disposal, and appearance of the floor and edges. Suppuration sometimes takes place as the result of a secondary infection. The pus-formation thus induced so transforms the clinical aspect of the condition as to overshadow the element of tuberculous infection. It is

reasonable to infer, from cumulative clinical experience, that the tendency to perforation is considerably greater in cases of ulceration of the appendix than in any other portion of the intestinal wall. There is but little pathologic evidence upon which to hazard an opinion as to the relative frequency in the appendix and cecum of cicatrization and healing by fibrous tissue formation. Surgical experience, however, relative to the discovery at operation of old adhesions and extensive fibrous tissue change suggests a somewhat greater tendency toward cicatrization in the appendix than in the intestine.

The *hyperplastic* form of tuberculosis of the appendix represents the same type of pathologic change as has been described in connection with the hypertrophic variety of tuberculosis of the intestine. The condition is characterized by a marked increase in the size of the appendix, its firm consistency, and its irregular contour. The diameter is often increased to such an extent that the cylindric shape is entirely lost. The surface is smooth, with occasional rounded protuberances. The wall is thickened by fibrous tissue proliferation, which sometimes encroaches upon the lumen sufficiently to produce a genuine stenosis. A slight degenerative change may be indicated by small yellowish spots. Areas of definite caseation and softening are recognized upon section. The microscopic changes are similar to those described as obtaining in the intestinal hyperplasia of tuberculous origin. Anatomic tubercles and tubercle bacilli are no more numerous than in the preceding condition. The conspicuous neoplastic feature of this form of tuberculous appendicitis, especially when associated with ileocecal hypertrophy, is such as to confound the condition clinically with new-growths of a malignant nature.

In plate 12 is shown a tuberculous appendix of the hyperplastic type removed from a pulmonary invalid October 7, 1907. This case, which is of unusual interest, will be reported presently.

Clinical Symptoms.—The symptoms referable to this form are usually more pronounced if the condition is accompanied by similar tuberculous hyperplasia of the cecum. When the fibrous tissue change is limited solely to the appendix and remains uncomplicated by mixed infection, there may be but *slight*, if any, *clinical evidence* of the condition. A connective-tissue hyperplasia of the cecum and appendix jointly is attended by pain in most instances. This is usually of a subacute type, but there are, however, occasional severe exacerbations, vomiting, and other evidences of digestive derangement. There may be indications of intestinal occlusion, with the demonstration of a circumscribed ileocecal tumor. Should a purulent process supervene in the appendix, there ensue the well-known manifestations of ordinary suppurative appendicitis.

The symptoms of the ulcerative type, which is of more common occurrence, do not differ essentially from those of non-tuberculous disease of the appendix. In some cases the subjective signs are quite indifferent and even devoid of suggestion of appendicular disease. At other times the evidence of acute or chronic inflammation, perforation, and peritoneal extension correspond accurately to the evolution of symptoms characteristic of non-tuberculous appenditicis. It should be emphasized that an ulcerative condition of the appendix of tuberculous origin is often identical clinically with ordinary appendicitis. The differential diagnosis is almost always impossible without the

laboratory examination, and the two conditions are subject to the same general principles of management. It is, therefore, futile among pulmonary invalids to endeavor to discriminate clinically between an ulcerative tuberculosis of the appendix and a non-tuberculous appendiceal involvement.

Tuberculosis of the appendix may exist in the absence of discoverable tuberculous lesions in other parts of the body. While pulmonary invalids often exhibit the classic features of simple acute appendicitis, more extended histologic examinations may reveal in the future its more frequent tuberculous origin. At present it may be assumed that this condition occurring among consumptives is not necessarily tuberculous in character. Assuredly it does not conform to any particular type as regards the clinical manifestations and indications for treatment.

Principles of Management.—Each individual case of appendicitis among consumptives, as well as among the non-tuberculous, must be adjudged in accordance with the *established principles* of *surgical procedure* to be applied according to the merits of the *appendicular indications*. It should be remembered that the *exigency relates solely* to the *appendiceal disease*, and not to the pulmonary involvement. Measures to avert an impending *general septic peritonitis* should take *precedence* over a chronic condition of the lungs which of itself is often self-limited. Some surgeons confess to considerable hesitation in performing the operation for appendicitis upon a consumptive, and advise delay unless the condition is especially acute. The position assumed appears illogical and non-subservient to the best interests of a class entitled to every prompt consideration. It is true that, from a surgical standpoint, the responsibilities are greater, and perhaps the results less uniformly spectacular, than among individuals in previous good health. This does not alter the fundamental truth, however, that the indications demanding operation among the non-tuberculous obtain to an *equal* if not *greater* degree among consumptives. On account of the diminished resistance of these invalids, delay is often more disastrous and attended by the assumption of far greater *moral* responsibility by the surgeon. It is not contended that the consumptive presents in all cases the same possibilities of speedy recovery as those who are not afflicted with pulmonary disease. This, however, is not the point at issue in determining the choice of procedure in such cases. The vital proposition relates to the question, whether or not the existence of pulmonary tuberculosis so complicates or modifies the problem, as to preclude upon this basis alone the rendering of surgical assistance.

A negative decision regarding the operation is not justified upon the score of the anesthetic unless the pulmonary disease is obviously so far advanced as to render recovery impossible, in which event ordinary discretion, of course, discountenances operation. It has been shown, however, in a previous chapter, that it is often impossible to assert with positiveness that a given case is beyond hope of ultimate arrest. I am well aware that the decision concerning operative interference, even in simple appendicitis, is often a choice of the lesser of two evils, and fraught with many anxious responsibilities. It is conceded that in a judicial estimate of the relative bearing of the many phases pertaining to an individual case, the existence of advanced phthisis may in exceptional instances constitute the determining consideration, and justly turn the balance of argument in favor of delay. Cases of this character,

however, do not comprise the category, concerning which doubt as to the expediency of operation is usually expressed by surgeons. As a matter of fact, the *bed-ridden* consumptive rarely exhibits evidence of an appendiceal involvement. From a close observation of over 2000 cases of pulmonary tuberculosis I can recall but a single instance of appendicitis developing in the last stages, and in this case Dr. Powers and I quickly agreed as to the futility of surgical intervention. It is submitted, however, that when a reasonable doubt is entertained, the invalid should be accorded the benefit of the doubt, and in case of *emergency* receive the *same prompt surgical aid* as the non-tuberculous. In the presence of *recognized imminent danger* from fulminating appendicitis, the peril of the *consumptive* is assuredly no less than his more fortunate fellow, and hence the rational advocacy of *equal opportunity* for surgical relief. An increased liability to succumb from the shock of the operation, even if true, would not militate directly against its ready performance in the face of conditions clearly indicative of its necessity under other circumstances. In this event failure to survive the surgical ordeal is not of itself condemnatory of the operation. On the other hand, when the conditions are not such as to involve a reasonable doubt concerning the propriety of the operation, no hesitation as to the choice of procedure should be permitted. In other words, a decision as to the relative advantages and disadvantages of the early and interval operations in such cases should be made upon the merits of the appendicitis itself, precisely as among individuals previously well, without taking cognizance of the existing pulmonary affection. Pulmonary invalids, as a rule, undergo anesthesia without special difficulty.

Important considerations in favor of operation are the *possibility of an abrupt termination* in the absence of surgical aid, the inevitable confinement incident to *prolonged convalescence* among *non-operative cases*, and the *added difficulty* in *sustaining nutrition* due to gastro-intestinal disturbances so often incident to chronic appendicitis and the ever-present danger of relapse. Failure to discover definite physical signs in the right iliac fossa in the presence of sudden chill, fever, nausea, vomiting, general abdominal pain, and prostration affords no assurance whatever of the non-existence of a grave appendiceal condition. The contention is made that in appendicitis there is no constant relation between the severity of the symptoms or signs and the nature of the pathologic change within the abdomen. There is no invariable rule by which to hazard an opinion concerning the existence of gangrene, perforation, pus-accumulation, circumscribing adhesions, or localized peritoneal involvement. The pathologic condition, without opening the abdomen, is at best a mere matter of conjecture, even in the absence of unfavorable symptoms. A considerable experience with appendicitis, both among pulmonary invalids and the non-tuberculous, confirms the belief that it is impossible in a given case to describe the pathologic process in the neighborhood of the appendix or to estimate with accuracy the imminence of threatening morbid change.

Some years ago I reported several cases of appendicitis among pulmonary invalids whose abdominal pain was general rather than local, with entire absence of tenderness or resistance over the region of the appendix upon careful physical examination. In two of these cases, upon opening the abdomen, free pus was found in the general cavity, with an exceedingly long appendix dipping over and below the

brim of the pelvis, where the tip had become adherent. This position of the distal end amply explained failure to elicit tenderness or rigidity upon early palpation, in spite of advanced pathologic change. These cases demonstrate conclusively that a genuine involvement of the appendix may exist without the exhibition of palpable evidence, although the general and constitutional symptoms may be sufficiently definite to characterize the attack as a most serious abdominal condition of some kind. Such an experience establishes the fact that, in the presence of severe abdominal pain of violent onset, with change in pulse and temperature, even despite absence of rigidity and tenderness over the region of the appendix, an absolute exclusion of appendicitis is quite impossible without recourse to exploratory laparotomy.

It may be regarded as unwarranted for an internist to formulate his own ideas, and base his conclusions as to a general course of action in appendicitis and other abdominal affections, from his comparatively restricted opportunities for observation. Irrespective, however, of the degree of familiarity with the recorded results of others, it remains for an active experience to crystallize one's views and define a general course of procedure with reference to this condition. Among pulmonary invalids as well as the non-tuberculous, appendicitis exhibits a startling prevalence, and an unnecessarily high mortality rate. So long as the daily press continues to record frequent deaths from a disease which at some period of its course is recognized by the medical profession to be distinctly curable, so long will there remain a justification for its most thoughtful and oft-repeated consideration. Although obviously a surgical condition, the discussion of appendicitis among phthisical patients appears particularly appropriate in a work devoted to pulmonary tuberculosis.

The position assumed by the attending physician concerning this affection is sometimes equivocal, compromising, and most unsatisfactory. Although not directly involved in the later surgical management of the disease, he is compelled, nevertheless, to accept an obligation fraught with infinitely greater responsibility than that assumed by the surgeon. It so happens, in the majority of cases, that it is the physician, rather than the surgeon, whose professional services are sought early in the disease. This is explained not only by the abiding confidence reposed in the family physician, but also through failure of the patient or friends to appreciate fully the character and possibilities of the ailment. Thus it is that at the very time when the hour-to-hour question of management is all vital to the life of the individual, the case is rested solely with the physician, the fate of the patient often depending upon the detail and accuracy of observation, the definiteness of purpose, and the promptness of action during the first twenty-four to thirty-six hours. There can be no greater reflection on the professional attainments and acumen of a physician than failure to recognize at once the possible nature of the disease and to arrange for operation at an opportune time, rather than to summon surgical aid after a period of disastrous and delusory expectancy. Upon the development of acutely violent abdominal symptoms, suggesting appendicitis or perforative peritonitis, few complicating conditions furnish legitimate contraindications for operation. In such an emergency the mere existence of pulmonary tuberculosis affords insufficient grounds for hesitation or delay.

A substantiation of the correctness of these views has seemed to be afforded from my experience with appendicitis among consumptives. An *early* operation has been performed upon 14 moderately advanced pulmonary invalids, with uniformly favorable results. In no case was there occasion to regret the operation, and in 11 instances it is fair to assert that life was saved through immediate surgical aid. In 3 cases it was impossible to conclude with positiveness that recovery might not have taken place without operation.

In addition to the 14 cases of early surgical interference, 3 others died from general septic peritonitis, the free abdominal cavity in each instance being filled with pus at time of operation. None of these patients succumbed from the effects of the operation *per se*, as the abdominal condition was such as to preclude recovery. In all cases the anesthetic was admirably borne. Six additional consumptives, with well-defined appendicitis for whom operation was not advised, eventually recovered from the appendiceal involvement, while one, refusing operation, died after a few days.

Objection has been made by some to operation among this class of patients through fear of a protracted convalescence, the formation of multiple abscess, and the possibility of fecal fistula. I have never found the surgical convalescence unduly prolonged among consumptives. Multiple abscesses have never been observed among my cases, and there has been but one case of fecal fistula. A small superficial sinus developed in two cases after operation, but subsequently healed.

For the purposes of illustration I will report briefly several cases of operation among advanced consumptives.

ILLUSTRATIVE CASES

Case I.—A woman, thirty-one years of age, came under my observation May 6, 1907, two years after the development of pulmonary tuberculosis. Despite a sojourn in several health resorts the general trend of the disease had been downward. There was a loss of twenty pounds in weight, with corresponding diminution of strength, a moderate temperature elevation, and slight cough and expectoration. The appetite was exceedingly poor and digestion much impaired. There were five or six loose bowel movements daily, attended by considerable abdominal pain. Tubercle bacilli were found in the fecal discharges. The examination of the chest disclosed extensive tuberculous involvement of each lung, upon the right side the infected area extending from the apex to the third rib and to the lower angle of the scapula; upon the left side, from the apex to the base in front and to the middle of the interscapular space. Under rigid hygienic and dietetic measures a moderate improvement was exhibited from May until October. There was an increase of ten pounds in weight, with gain in the general strength and a continuous reduction of fever. There remained, however, considerable impairment of digestion, with loose bowel movements and occasional colicky attacks of pain of short duration. Upon October 4th she experienced severe pain in the right iliac region, accompanied by a slight rigor and vomiting. This was followed by moderate temperature elevation and acceleration of pulse. The abdomen was extremely tender and rigid upon the right side. A diagnosis of appendicitis was made, but on account of her general condition, a decision as to the

advisability of operation was held in abeyance for a few hours. Upon the following day there was a complete remission in the severity of the symptoms, the pain disappearing entirely, the temperature returning to normal, and the pulse to 96. The condition of the abdomen, however, was unchanged. No food was administered by the mouth, and further delay appeared justifiable. During the evening of the second day the patient suffered another chill, with recurring pain, renewed temperature elevation, and vomiting. Immediate operation was urged, but stubbornly refused. Despite emphatic insistence upon recourse to surgical measures, consent was not obtained unil the morning of October 7th, the temperature in the mean time having risen to 103° F., and the pulse to 136. The operation was performed by Dr. Powers, and a tuberculous appendix of the hyperplastic type was removed. Although

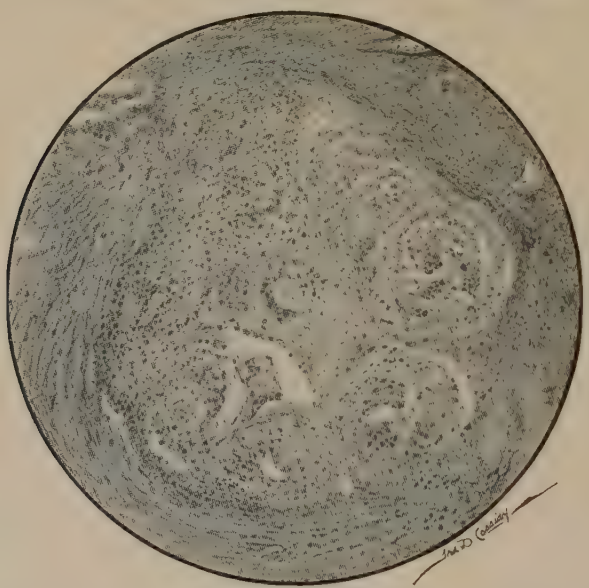


Fig. 125.—Drawing of miliary tubercle of the appendix. (See plate 12.) Note the well-defined connective-tissue reticulum and the giant-cell in the center, with circular mural disposition of the nuclei. Note central areas of degeneration and cellular proliferation in the periphery.

the cecum was also found the seat of similar tuberculous involvement, the general condition of the patient precluded resection of the bowel. The patient made an uneventful recovery from the operation, although a fecal fistula persisted.

An interesting feature of this case was the diagnosis before operation of the tuberculous nature of the appendiceal involvement. This is explained by the fact that $\frac{1}{2000}$ of a milligram of the new tuberculin had been administered less than twenty-four hours prior to the development of appendiceal symptoms. The acute onset following the institution of tuberculin treatment suggested a *probable relation* of *cause* and *effect* in the way of a local and general reaction. The hard, irregular, and nodular mass, as it appeared immediately after removal, is shown in plate 12, figure 1. After hardening in a 2 per cent. solution of formalin for two days, the mass was incised, and showed well-marked caseation

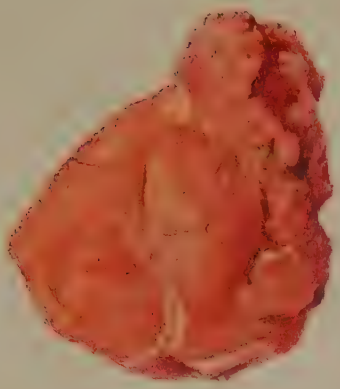


Fig. 1.—Hyperplastic tuberculous appendix removed from pulmonary invalid. Note irregular contour with rounded protuberances. The needle is inserted partly into the lumen. Compare with following illustration representing the appendix upon section. The histologic appearance is shown in Fig. 125.

Fig. 2.—Section of tuberculous appendix of the hyperplastic type, hardened in formalin for two days before being incised. Note in each half the characteristic tuberculous caseation, with well-defined areas of softening and partial obliteration of the lumen. Compare with preceding illustration, same specimen.

with small areas of softening. There was an almost complete obliteration of the lumen of the appendix. The appearance of the specimen at that time is shown in plate 12, figure 2. Typical tubercle formation was recognized upon microscopic examination, as shown in the accompanying illustration (Fig. 125).

Case II.—The patient was a young woman who came under my observation September 29, 1902, when twenty-one years of age. Four members of her immediate family had died of consumption. Her pulmonary involvement had been of two and one-half years' standing. She had resided in Colorado for two years, during which time progressive failure had taken place. The patient was greatly emaciated, exhibiting considerable temperature elevation daily, and suffering from numerous loose bowel movements. Tubercle bacilli were found in the rectal discharges. There was extensive tuberculous ulceration of the larynx. The examination of the chest showed tuberculous involvement of the greater portion of right lung, without cavity formation. After the lapse of two years a remarkable improvement took place. Abdominal distention and diarrhea had ceased altogether, cough and expectoration had markedly diminished, the weight had increased over thirty pounds, and the tuberculous involvement of the larynx had improved to such an extent that local treatment was suspended. The examination of the chest disclosed an evident quiescence of the tuberculous process, although complete arrest had not thus far been secured. Shortly after this she married, and assumed the responsibilities of housekeeping, following which she lost in weight and exhibited renewed activity of the tuberculous infection. In July, 1905, she developed a typical acute appendicitis and was hurried to operation a few hours after the development of initial symptoms. The patient had not been under medical observation for eight or ten months prior to this time, and her general condition was far from favorable. The operation was performed by Dr. Dixon, and a much enlarged and inflamed appendix removed. The patient made a prompt and uninterrupted recovery. At present there are no signs of activity of the tuberculous disease. The examination of the chest is negative, with the exception of fibrosis. There are no bacilli in the sputum, no evidences of intestinal disturbance, and a complete healing of the laryngeal involvement.

Case III.—A man of forty-eight with a family history of tuberculosis came to Colorado ten years ago on account of extensive tuberculous involvement of the left lung. After several years of rational living there was secured a complete arrest of the tuberculous process. In 1904 the patient experienced a beginning digestive disturbance, with constipation, intestinal flatulence, and fleeting attacks of pain referred to the region of the appendix. As a result of the digestive disturbance and impaired appetite, there took place a progressive loss of weight and strength, accompanied by a renewed activity of the tuberculous process in the lung. The weight was reduced nearly forty pounds and the vitality much enfeebled. In April, 1906, there was a sudden attack of pain in the right iliac fossa, without vomiting or temperature elevation. There was absolutely no resistance or rigidity of the muscles of the right lower abdomen. The face was pinched and ashen. Upon deep palpation a small tumor was recognized well to the outer edge of the abdomen. Laparotomy was immediately performed in spite of extreme prostration, malnutrition, and active pulmonary tuberculosis. The

decision to operate was based in part upon the expediency of removing a possible cause for the protracted digestive derangement. It was felt that even a disappearance of the acute stage of inflammation, with remission of the urgent symptoms, would leave the patient with but slight opportunity to secure arrest of the pulmonary infection. Operation performed by Dr. W. A. Jayne disclosed a much elongated and thickened appendix, with beginning gangrene. The patient recovered promptly from the effects of the surgical procedure, and has since attained a complete restoration of his previous health. There has been a conspicuous gain in weight (25 pounds) and strength, with entire absence of physical signs of the pulmonary affection.

Case IV.—A boy, nine years old, was brought to Colorado June 1, 1903, after several months' progressive decline in New Mexico. There was extensive active involvement of the left lung and a moderately advanced tuberculous process in the right. There were great emaciation and physical debility, moderate temperature elevation daily, and an exceedingly weak and rapid pulse. No hope of securing an arrest was entertained. After three months of complete rest in bed in the open air, with active efforts toward superalimentation, a gain of fifteen pounds was established, with corresponding improvement in the general condition. The strength again was reduced by a six weeks' illness with typhoid fever, upon recovering from which a satisfactory improvement in the general condition was continued until January, 1905, when an appendicitis developed with moderate pain and vomiting. There was no fever, the resistance in the right iliac region was very slight, but the pulse was 130 and of poor quality. The question was presented as to the expediency of operating upon a ten-year-old boy with advanced phthisis and a poor general condition, in the absence of parents. There was some hesitation as to the wisdom of surgical interference on account of the lack of tenderness, temperature elevation, and rigidity, suggesting that the condition was not especially acute. After some hours' delay it was decided to assume the responsibility of operation. A gangrenous appendix was removed by Dr. Dixon, and speedy recovery ensued. Complete arrest of the pulmonary tuberculosis has since been secured. The child has been at home for over two years, and I am advised exhibits no evidence of renewed activity of the tuberculous infection.

Case V.—The patient was a woman, forty-two years old, who arrived in Colorado in June, 1906, presenting the history of advanced pulmonary tuberculosis of four years' duration. There was marked loss of weight, dyspnea, and rapid pulse. Each lung was extensively diseased, an active infection being recognized upon the right side from the apex to the third rib, and upon the left from the apex to the fourth rib, with pronounced pulmonary excavation. An unfavorable prognosis was necessarily entertained. Improvement, however, was noted during a period of two months, after which she experienced sudden pain, nausea without vomiting, moderate elevation of temperature, and increased rapidity of the pulse. Very slight resistance was obtained in the right iliac region. Immediate operation was advised, although due cognizance was taken of the responsibility assumed in surgical interference upon a case of this character. It was feared that if the appendix was permitted to remain, convalescence would be unavoidably protracted, and alimentation greatly reduced. An acutely inflamed and elongated appendix was removed by Dr. Dixon. The subsequent

history of the case will be reported in connection with Clinical Observations upon the Use of Bacterial Vaccines. The improvement in the general and pulmonary conditions has been pronounced.

Case VI.—A pulmonary invalid, thirty-four years of age, while in the mountains of Colorado in the summer of 1906, suddenly experienced fairly acute abdominal pain, which was followed by chill and vomiting. After remaining in bed for several days the acuteness of the pain subsided somewhat, and the general condition was so improved as to permit his undertaking a twenty-five-mile ride to the nearest railway station. By the merest chance I met the patient upon the way, and was solicited to render medical aid. The patient was emaciated, extremely pale, with weak and rapid pulse, but no elevation of temperature. Examination made at the time showed a generally distended abdomen. There was no especial localization of the pain or tenderness in the region of the appendix. The patient was removed to Denver, and operation decided upon in spite of a poor general condition, pulmonary involvement, and a considerable degree of uncertainty as to the precise nature of the abdominal disturbance. A circumscribed ileocecal abscess was evacuated by Dr. Powers, but efforts to discover the appendix were unavailing. The patient made a satisfactory recovery.

Case VII.—A woman, thirty-two years of age, having resided in Colorado for four years on account of an extensive tuberculous involvement of each lung, suddenly experienced, upon November 30, 1905, severe abdominal pain in the right ileocecal region. This was attended by chill and vomiting. She had previously secured a gain of about fifty pounds in weight, and a pronounced improvement in the pulmonary condition. The face was flushed, expression anxious, temperature slightly elevated, and pulse 130. Careful examination of the abdomen was entirely negative. After two or three hours a beginning tenderness with slight resistance was noted in the right iliac region. Operation was decided upon, and performed without delay by Dr. Dixon. There was found a perforative gangrenous appendix with beginning general septic peritonitis. The appendix was removed and thorough drainage instituted. The patient, however, died upon the third day. This case is of interest in view of the fact that the fatal termination occurred not by virtue of the pulmonary involvement, but as the result of a perforation of the appendix which probably took place simultaneously with the very *earliest symptoms*. Had there been exhibited evidence of appendiceal disease *prior* to the perforation, recovery would undoubtedly have taken place notwithstanding the pulmonary disease.

Case VIII.—The patient, a woman, aged thirty-three, with a long-standing tuberculous process in both lungs, experienced a sudden acute pain during the night of February 13, 1901. This was followed almost immediately by a chill, and subsequently by vomiting. She was seen by me on the following morning. The temperature was but slightly elevated, the pulse was of good quality and not especially rapid. The pain in the abdomen, which was general rather than localized, had materially subsided. Careful physical examination failed to disclose the slightest tenderness or resistance over the region of the appendix. During the next twenty-four hours no especial change was noted in the condition. No nourishment was permitted by mouth. Shortly afterward the pain became more severe, and was attended by renewed vomiting and a slight chill. The next morning the physical exami-

nation remained completely negative. The expression, however, was not so good as on the preceding day. After consultation and a continued negative result of abdominal, vaginal, and rectal examination, it was determined to resort to exploratory incision. The operation, unfortunately, was delayed another twenty-four hours, during which time the temperature rose to 104° F., the pulse to 136. The abdomen had become distended, and the whole picture was that of septic peritonitis. The operation was performed by Dr. Horace G. Wetherill. On opening the abdomen free pus was found throughout the general cavity. The appendix was exceedingly long, with its tip dipping down over and below the brim of the pelvis, where it had become adherent, thus explaining the failure to elicit tenderness or rigidity on early examination. Perforation had taken place, and the appendix was gangrenous in places. The patient's condition during the operation was extremely desperate. She was taken from the operating-room in collapse, and it was not doubted that death would speedily ensue. During the next two or three days the condition remained as desperate as can be imagined. The pulse was exceedingly weak, the temperature considerably elevated, and the abdomen greatly distended. Fecal vomiting began on the third day following the operation, and the patient became practically unconscious. In spite of vigorous efforts the bowels had not moved, and there had been no passage of gas. It was evident that the stomach must be relieved of the fecal matter and the intestinal distention reduced as much as possible. While the patient was in a semicomatose condition, the stomach was washed out at very short intervals with a solution of soda. Enormous quantities of gas were removed at each washing, together with considerable fecal matter. The lavage was continued in each instance until the water returned perfectly clear. It was remarkable to note the very decided relief of the abdominal distention after each washing. The improvement in the mental condition soon became marked. Stimulation was vigorously continued, and the lavage was repeated at short intervals during the next three days. Renewed efforts to move the bowels were finally successful, and in the course of a week normal peristalsis was restored. The patient continued to exhibit gratifying improvement for a period of nearly seven weeks, when there suddenly developed symptoms of acute intestinal obstruction. Operation by Dr. Wetherill disclosed very extensive intestinal adhesions, and the patient survived but a few days.

This case is cited as illustrating the statement previously made that a genuine involvement of the appendix may exist without any early evidence of its presence being elicited upon physical examination. In this case the general and constitutional symptoms were sufficiently definite to characterize the attack as a most serious abdominal condition. Through failure to discover definite physical evidences of appendicitis there was permitted to take place a most disastrous period of delay, which resulted eventually in the death of the patient. The lesson to be drawn from such an experience is plain to the effect that, in the presence of such an acute onset, severe abdominal pain, with change in pulse and temperature, even despite absence of rigidity and tenderness over the region of the appendix, the only safe and rational course would have been to perform an exploratory laparotomy. The dangers of opening the abdomen in such cases are comparatively slight, while the

unfortunate possibilities from delay are very great. When in doubt early in the course of such acute abdominal affections it must be recognized that the best interests of the patient are subserved by exposure to the relatively slight dangers of abdominal section, in order to secure, first, definiteness of diagnosis, and, secondly, opportunity to invoke life-saving surgical aid.

Case IX.—The patient, aged fifty years, came to Colorado September 6, 1906, one year after the development of pulmonary tuberculosis. There were great emaciation and physical debility. Dyspnea was pronounced upon sight exertion, and the cough was frequent and paroxysmal. The expectoration, was profuse, the appetite poor, and the sleep much disturbed. Physical examination disclosed extensive active tuberculous infection of the right lung and slight involvement of the left. No appreciable improvement was noted after several months' residence in Colorado. Early in 1907 the patient developed an acute appendiceal attack. The initial rigor was severe, and the pain in the right iliac region excruciating. Immediately after the early vomiting the pulse became exceedingly weak and rapid. The patient was seen in consultation by Dr. F. L. Dixon, and much hesitation, in view of the extreme physical debility, was felt as to the expediency of operation. Despite the unfavorable general condition, however, it was decided that the invalid was entitled to the same operative procedure that would be accorded a non-tuberculous patient. An acutely inflamed and beginning gangrenous appendix embedded in a mass of inflamed and gangrenous omentum was removed, and the patient made an uneventful recovery.

Dr. Powers has recently operated upon a tuberculous patient of Dr. J. A. Wilder presenting symptoms of acute fulminating appendicitis with a history of several former attacks. At the time of the previous illness it was decided to resort to an interval operation as soon as practicable. This was subsequently opposed by the patient and family on account of the far-advanced tuberculous condition. He suddenly experienced severe pain, chill, and underwent immediate collapse. Under great stimulation the operation was performed and the appendix found to have sloughed directly over the wall of the cecum, leaving a patulous opening into the intestine which discharged its fecal contents into the general abdominal cavity. The appendix itself was extensively gangrenous. The abdomen was freely and continuously irrigated for many days with the patient in the Fowler position. Recovery took place, and the patient was permitted to resume the effort to secure arrest from the pulmonary involvement.

This case offers a striking illustration of the wisdom, in general, of the interval operation upon the pulmonary invalid, when the history of previous attacks establishes the diagnosis of recurring appendicitis.

CHAPTER LXIX

RECTAL FISTULA

This condition originates from abscesses in the connective tissue surrounding the lower portion of the rectum. It usually results from neglect in the treatment of simple anal abscess or in that of a similar pus-collection in the ischiorectal fossa. Among tuberculous patients, however, a persisting indolent fistula may develop despite thoroughly efficient surgical treatment of the original abscess.

There are several types of fistula, one of which is the open variety, with a free communication to the external skin, as well as into the intestinal canal. Another is termed the blind internal fistula, in which the sinus opens into the bowel but has no external outlet. The blind external fistula opens upon the skin, but does not perforate the rectum. Irrespective of the type of fistula, the course of the sinus in almost every instance is tortuous and irregular. The point of internal perforation is frequently but a short distance above the anus, though in some cases the sinus extends upward a considerable distance before penetrating the bowel. The external opening may be situated in immediate proximity to the anus or at a distance of several inches. The discharge of pus or liquid feces from the sinus produces, as a rule, considerable discomfort and irritation. In most cases there is a comparative lack of pain and tenderness. The discharge varies according to the nature of the infection. When of tuberculous origin, the secretion is often scant and watery in character. In case of mixed infection it is usually more profuse, of greater density, and of a greenish-yellow appearance. Tuberculous fistulæ are apt to exhibit at the cutaneous orifice a reddened, irregular, and overhanging edge.

The method of origin of small abscesses arising from the anal diverticula is closely analogous to appendicitis with pus-formation. Opportunity is afforded in both conditions for the entrance of numerous different microörganisms. Their presence, together with the indefinite retention of fecal matter and foreign substances, gives rise to varying degrees of irritation and inflammatory change.

In reviewing the general etiology of tuberculous lesions of the intestinal tract attention was called to the mechanic facilities offered for the lodgment of tubercle bacilli in the tiny lacunæ existing in the mucous membrane above the anus. This explains the distinctly tuberculous origin of many cases of rectal fistula. While in a considerable number of cases the fistulous abscesses are in themselves tuberculous, a *non*-tuberculous fistula is not infrequent among pulmonary invalids. Although nearly 15 per cent. of all fistulæ occur among this class of people, the local condition is not invariably tuberculous.

The relation of fistula in ano to pulmonary tuberculosis has been the subject of much uncertainty and confusion for many years. The proportion of consumptives afflicted with anal fistula varies, according to different observers, from 2 to 5 per cent. The condition has existed in slightly over 2 per cent. of the cases coming under my personal observation. It was even thought at one time that the existence of fistula produced a degree of immunity to pulmonary tuberculosis. Among non-consumptives, therefore, it was considered rational to

prevent the healing of the sinus for fear lest a tuberculous infection of the lungs would subsequently develop. If the victim of the fistula was a consumptive, the chances for recovery from the pulmonary disease were believed to be enhanced by a continuance of the fistula, and materially diminished by its closure. According to Freeman, it was at one time considered good treatment to produce artificial fistulæ in consumptives as a means of cure of the original disease, upon the theory that injurious humors were thus drained from the system.

At present there exist considerable differences of opinion as to the true relation of these two affections, and especially as to the applicability of remedial measures under varying conditions. It is well to bear in mind, as stated, that tuberculous fistulæ may occur in individuals presenting no other evidence of similar infection, and that non-tuberculous fistulæ may sometimes develop in the midst of pulmonary phthisis. In this respect there is maintained a further resemblance between abscesses in the appendix and in the region of the anus. There is, however, in the two conditions a striking difference as to the practical construction to be placed upon these relations. In connection with appendicitis it was stated that a clinical distinction was unnecessary between tuberculous appendicitis and a simple inflammatory involvement among consumptives, as the indications for treatment were identical. The principles of management as applied to cases of rectal fistulæ, however, are not similarly uniform, for reasons that are perfectly obvious. Appendicitis, regardless of its origin, is recognized as a distinct menace to life, without immediate operation. Rectal fistula, however, at no time threatening the life of the individual, is embraced under an entirely different category, the results of surgical treatment being dependent upon the influence of the general health.

It is important to distinguish between fistulæ in themselves tuberculous without evidence of infection in other parts of the body, and fistulæ in consumptives irrespective of the origin. Among the latter the essential consideration is not the local condition of possible tuberculous origin, but the existence of an infection in remote parts, causing a diminished resistance of the tissues and retarding, if not preventing, complete union after operation. In this event surgical interference may become non-effective and may even react to the disadvantage of the patient through the refusal of the wound to heal, the increased area of broken-down tissue, the occasional impaired function of the sphincter, and the not infrequent mental depression.

The decision as to therapeutic management must be based upon certain prognostic considerations which relate directly to the extent of pulmonary tuberculosis and the general vitality. *Tuberculous* fistulæ in otherwise healthy individuals are subject to the same principles of radical surgical management as simple fistulæ among the same class of patients. In consumptives the special indications for the operation relate to the supposed ability of the tissues to heal promptly after thorough excision. Surgical interference among pulmonary invalids as a class has fallen into considerable disrepute because of the frequent unsatisfactory results of the operation. It must be admitted that among these patients it is notoriously unsuccessful in a large proportion of cases. It is well known that the course of the pulmonary disease is not influenced either for better or worse by the complicating fistula, save for the unfavorable results sometimes noted after ill-

considered and untimely surgical procedures. The alleged development of pulmonary tuberculosis following operation for rectal fistula is probably explained by the previous latency of the pulmonary infection and its delayed clinical recognition. On the other hand, the influence of advanced pulmonary phthisis upon the local fistulous condition is beyond question.

The unfortunate results of operation upon consumptives are frequently traceable to the lack of proper discrimination exercised as to the selection of cases. The operation is often performed upon invalids with advanced pulmonary disease, or at a time when the infection, though of recent development, is associated with greatly impaired nutrition and lessened individual resistance. The essential consideration as to the propriety of the operation attaches not to the *extent* or *duration* of the tuberculous change in the lung, but rather to its comparatively slight *activity* and the *existence* of an *excellent nutrition* as indicative of general vitality. It is my custom to deny this operation to patients until the pulmonary infection has undergone almost if not complete arrest, with the restoration of at least a normal body weight. Until such time patients are quieted with the assurance that the persisting fistula exercises no possible influence upon the disease, and that a fortunate result of operation is permitted only by an increased general resistance. A significant commentary as to the frequency of ill-advised operation is the fact, that in nearly every instance of rectal fistulæ among pulmonary invalids at the time of coming under my observation an operation had previously been performed with unsatisfactory result.

The surgical management, aside from ordinary drainage operations which are indicated in all cases of abscess formation in this vicinity, consists of simple incision with curetment, or of total extirpation of the fistulous tract. Incision is the less formidable and more usual method of procedure, and is sometimes attended by satisfactory results. In case of a complete open fistula a grooved director is passed from the external opening into the rectum, and the intervening tissues divided with a sharp curved bistoury. This is preceded by thorough stretching of the sphincter. If the fistula is incomplete, a connection must be established from the skin to the interior of the bowel by the director. After the entire sinus has been laid open, the infected area is forcibly scraped and sterilized with pure phenol. The wound is packed with iodoform gauze, the healing taking place by granulation.

The process of excision, which is more likely to be attended by a speedy and gratifying result among tuberculous cases, consists of the dissection of the entire fistulous canal. Great care must be taken to remove, if possible, a considerable area of apparently non-infected tissue. This procedure is even advisable in chronic cases exhibiting dense fibrous tissue formation along the wall of the sinus. After cleansing and sterilization, the wound is closed with silkworm-gut sutures in an effort to secure accurate coaptation of the walls. Especial care should be taken to bring the parts in perfect apposition at the anal end of the sinus. For this purpose the ends of the sphincter muscle should be united by a suture encircling and passing through the muscle. Primary union takes place in a large proportion of cases. If asepsis is imperfect and suppuration ensues, the stitches should be immediately removed and the reopened wound packed with gauze, thus permitting healing to take place by granulation.

SECTION VII

TUBERCULOSIS OF THE GENITO-URINARY TRACT

CHAPTER LXX

GENERAL ETIOLOGIC CONSIDERATIONS

TUBERCULOUS infection of either the genital or urinary system is almost always secondary to a preëxisting focus in some other portion of the body. It is difficult, however, to deny absolutely the possible existence of primary tuberculosis in these parts. Isolated cases of such an infection are found in the literature of the subject, but the evidence is frequently insufficient to sustain the assertion that the reported condition is one of genuine primary infection of the genito-urinary system. The term *primary* is often used in connection with tuberculosis of this region, not as denoting the *initial* site of infection of the *entire organism*, but rather as indicating a priority of involvement in a given portion of the genito-urinary system in comparison with infection of neighboring parts. In discussing the general etiology of tuberculous infection of the genito-urinary tract, the word *primary* will be used simply in the sense of its *local* application, it being well understood that the infection must proceed in all cases from some antecedent, though often undiscoverable, focus.

The primary origin of tuberculous lesions in these regions and the subsequent sequence of infection have been the subject of much investigation. In the past decided differences of opinion have been entertained as a result of clinical and pathologic research. Following much experimental study in recent years, there is a greater unanimity of medical opinion as to the preponderating sites of infection and the more common *direction* of further dissemination. The parts most frequently involved are the kidney, Fallopian tubes, epididymis, and prostate. It is known that the tuberculous process may be primary in any of these organs. From a *clinical* or *surgical* standpoint it is fair to assume that the so-called primary origin of the disease occurs with almost equal frequency in the kidney, epididymis, and Fallopian tubes, with the prostate gland less commonly the seat of early infection. *Research work* now being conducted at the Phipps Institute in connection with renal tuberculosis forces the conclusion, however, that the *kidney* is by far the *more frequent site of infection.* The urine of 60 patients with pulmonary consumption was exhaustively examined for the recognition of tubercle bacilli. After eliminating all possibility of error resulting from the possible confusion of the bacilli with other micro-organisms, it was found that the examination in 44 instances was attended by a positive result. This work was of importance in showing that tubercle bacilli were being excreted with the urine of phthisical patients to a much greater extent than had been generally supposed. The result was susceptible of a double interpretation—first, that the bacilli had been filtered from the blood through the glomeruli without

local lesion along the urinary tract, and, secondly, that genuine tuberculous lesions existed either in the kidney or along the downward course of the urinary system.

Heiberg and Morris report tuberculosis of the kidney to be found at autopsy in only 2 per cent. of the cases of pulmonary tuberculosis. Hamilton has shown that after the bacilli gain entrance to the circulation, they may be found in the glomeruli of the kidney, within the afferent arteries, in the interstitial tissue, and in the uriniferous tubules. Walsham, in his study of excretion tuberculosis, has demonstrated the presence of bacilli in the glomeruli without evidence of change in the surrounding tissues or in the vessels of the glomerulus. He has proved that the bacilli may become arrested at some point in the uriniferous tubes, often in the medulla of the kidney, and produce secondary foci of tuberculous infection. His views as to the epithelial spread of the infection in the kidney are indorsed by Benda, who calls attention to the presence of bacilli *en masse* in the midst of the epithelial constituents of the kidney in the common, straight, and convoluted tubules. He emphasizes the extension of tubercle deposit from the straight and common uriniferous tubes in explanation of the origin of renal tuberculosis in the medullary substance, but ascribes the infrequency of dissemination from the convoluted tubes in the cortex to the plugging incident to the tuberculous processes. Apropos of Walsham's study the further investigations at the Phipps Institute under the supervision of Walsh are of special interest. Sixty autopsies were performed upon tuberculous subjects, and the kidneys in each instance were cut into very small pieces and subjected to careful macroscopic and histologic examination. Definitely typical tubercles were found in 35 cases. In addition, the condition in other cases closely resembled a tuberculous invasion of the kidney, an assumption as to its probable character being justified by the presence of miliary tubercles in other organs. If the latter instances be included, a tubercle deposit was found in 63 per cent. of the cases. Out of 37 cases examined by Hein, tubercles were found in 21 instances, or about 57 per cent. In the light of such pathologic data it must be accepted that tuberculosis of the kidney exists in approximately one-half of the cases of pulmonary tuberculosis, and to a greater extent than in any other portion of the genito-urinary system. These results are in striking contrast to Senn's recent estimate that one out of every 18 consumptives exhibits a tuberculous process in some portion of the genito-urinary system. The pathologic institute at Prague has reported but 5.6 per cent. of renal tuberculosis recognized at autopsy upon adult consumptives, while Rilliet and Barthez report 15.7 per cent. among children.

It is probable that the frequency of primary involvement of the epididymis corresponds fairly closely to that of the Fallopian tubes. As a result of tuberculous infection of the epididymis an extension of the process may take place to the seminal vesicles, prostate, and sometimes to the bladder. From the Fallopian tubes the infection may be disseminated to the ovary, uterus, and peritoneum.

Primary tuberculosis of the bladder is exceedingly rare. Its secondary involvement may proceed from a downward infection originating in the kidney, or from an upward distribution emanating from the prostate or male genital organs. It is doubtful if upward extension of the tuberculous infection may take place from the bladder to the

kidney. Giani has concluded, as a result of his own experimental research, that ascending tuberculous infection to the kidney is absolutely impossible against a normal downward current of urine. The mode and direction of tuberculous infection involving both the genital and urinary systems, with the bladder as more or less a neutral point, were formerly a greater bone of contention than at present. Cornet believes urogenital tuberculosis to be almost always ascending in character, its origin in most cases being traceable to the genitals. He, therefore, regards tuberculosis of the urinary apparatus as generally secondary to that of the genital system, and states that "this conception is almost universally adopted." He bases his conclusions upon his clinical experience with individual cases and upon the greater relative frequency of genital than of urinary tuberculosis, as shown by the autopsy reports of several foreign observers.

It is important to call attention to the fact that statistical reports concerning the *relative frequency* of tuberculous lesions in various parts of the genito-urinary system, are in themselves of little value as constituting a basis for conclusions concerning the primary seat of the disease and the method and direction of extension. It is even impossible to differentiate with accuracy the priority of the various tuberculous deposits by a comparison of their stages of development. It should be remembered that the age of lesions *per se* in any part of the body is not a determining factor in the degree of their development.

Cornet explains the ascent of the bacilli to the kidneys partly by extension along the surface of the ureters, partly through the lymph-channels of the mucous membrane, and to some extent by regurgitation of infected urine. He opposes the theory of downward extension from the kidneys to the bladder upon the basis of the washing process incident to the flow of the urine. He cites numerous cases reported by observers in substantiation of his theory regarding primary involvement of the genital organs, and the subsequent ascending infection. He regards the prostate as the most important site of the primary process in the male, and the Fallopian tubes in the female. He describes at length the numerous possibilities of *exogenous* infection, and explains the relative infrequency of tuberculous lesions upon the external genitals by the supposedly analogous penetrability of the mucous channels by the gonococci. In support of his theories he describes with much circumstance the opportunities for the development of genital tuberculosis either through auto-infection or otherwise. Even were other clinical and pathologic facts not distinctly antagonistic to this view, it would still appear difficult to reconcile such an opinion to the not infrequent development of genito-urinary tuberculosis among *children*. Numerous instances have been reported of this infection among the very young. Morse has recently cited a case of tuberculosis of the kidney in an infant of six months, the bacilli being demonstrated in the urine microscopically, culturally, and by animal inoculations. It certainly involves a vivid stretch of the imagination to explain any considerable number of instances of genito-urinary tuberculosis among the very young upon the fancied theory of infected towels. Baumgarten has endeavored to show by experiments upon animals that the course of the tuberculous infection follows the flow of the secretions, the direction extending *downward* from the kidneys to the bladder and *upward* from the testicle toward the prostate. The consensus of modern opinion,

however, based upon the results of exhaustive study, points to the principal mode of infection as emanating from the *circulation*.

Ascending infection in some portions of the genito-urinary tract is not to be denied in occasional instances. There undoubtedly occurs an upward extension from the epididymis to the testes, and from the prostate to the bladder. The involvement of the kidney, however, may usually be regarded as primary and filtrative from the blood. Inability to demonstrate the presence of bacilli in the blood in such cases, affords no valid argument against this method of infection, as it is well known that even in acute miliary tuberculosis with abundant tubercle formation in the kidney, blood examinations have been repeatedly negative in character. It is worthy of note that tuberculosis of the kidney in women, among whom there is no opportunity for upward extension to this organ from the genital tract, is found at autopsy nearly twice as often as in the male sex. The infection may sometimes take place through the capsule of the kidney, as a result of direct extension from a neighboring tuberculous process. It may be assumed that in a few isolated cases of renal tuberculosis trauma has caused the development of active manifestations among patients in whom the condition had previously been latent.

CHAPTER LXXI

TUBERCULOSIS OF THE KIDNEY

The chief clinical interest attaching to tuberculosis of the genito-urinary system relates to the involvement of the kidney. Tuberculous infection of this organ is exceedingly common among pulmonary invalids, as shown by the statistical data, to which allusion has been made in the previous chapter. Autopsy observations indicate that the condition is bilateral in from 50 to 60 per cent. of the cases. Bevan has referred to the report of 12,732 autopsies at Kiel. Among the cases of renal tuberculosis, 62.3 per cent. were bilateral and 37.6 per cent. unilateral. These results are in striking contrast to the infrequency of bilateral involvement as observed at the operating table. Upon the basis of the clinical evidence alone renal tuberculosis is bilateral in not over 15 per cent. of the cases. Israel found over 90 per cent. unilateral, as did Facklan. Kümmel reported 88 per cent. unilateral and Krönlein, 92 per cent. Rovsing reported a unilateral infection in 216 out of 350 cases. These results strongly suggest an involvement limited to a single kidney in cases of initial renal tuberculosis. The necessity of an early recognition of the condition is thus apparent, as well as the wisdom of more prompt recourse to surgical interference. It must be remembered, however, that such evidence is entirely of a clinical nature, and that, in fact, the condition is bilateral much oftener than is indicated by the general symptomatology or the results of clinical examination. In view of the histologic studies of Walsh as to the frequency of tubercle deposit in the kidneys of consumptives, it is apparent that the diagnostic evidences of tuberculous infection are

often absent. The clinical data alone might seem to establish merely a unilateral involvement. An assumption as to the non-limitation of the disease to a single kidney must not be construed, however, as an argument against the rationale of radical surgical measures directed to the seat of the *recognized* involvement.

Pathology.—The primary pathologic condition is the deposit of numerous tubercles in the kidney. These are at first discrete, but subsequently exhibit a rapid coalescence. In acute miliary tuberculosis the tubercles are found chiefly in the cortex, and occur merely as a part of a general miliary involvement of other organs. It has been questioned if the miliary nodules of the kidney proceed to genuine caseation before the death of the patient. The evidence from numerous pathologists is to the effect that caseation takes place extremely early in these cases, and that this condition is frequently observed at autopsy among patients succumbing to acute miliary tuberculosis. This is particularly true of the tuberculous nodules in the cortical substance of the kidney, and especially as they approach the surface, in contrast to the tubercle deposit in the medulla. The nodules of the cortex are almost uniformly of small size, comparable to that of the millet-seed, but may sometimes attain the dimensions of a large pea. Hamilton calls attention to a change in the shape of the nodules according to their locality, being wedge shaped upon the surface of the cortex, more rounded within the cortical substance, and fusiform within the medulla. He asserts that caseation takes place as soon as the nodule is sufficiently large to permit macroscopic recognition. In the non-miliary form small tuberculous nodules may arise from within a tiny blood-vessel in the cortical substance, or within one of the uriniferous tubules. In the former instance the infection is clearly hematogenous in origin, and in the latter, excretory. In either event, whether the center of the primary focus be situated within a blood-vessel, in the cortex, or within a urinferous tube, extension and coalescence of adjacent tubercles rapidly take place. Caseation and softening supervene, and the parenchyma of the kidney becomes broken down into cavities filled with pus and débris. As a result of the abscess formation and necrosis, the entire kidney is sometimes transformed into a single pouch of broken-down tissue, or there may be multiple discrete abscesses with well-defined septa. Nodules may appear upon the kidney surface, and produce an infection of adjacent structures. The process may extend peripherally through the capsule of the kidney and result in the formation of perinephritic abscesses. The infection may travel downward, causing a tuberculous involvement of the ureters and bladder. The walls of the ureters may become thickened throughout the entire course, and ulcerations develop upon the mucous surface. Stenosis of the ureter may be produced by the occlusive effect of the inflammatory thickening, in conjunction with the presence of débris. This may result in the retention of urine and dilatation of the pelvis, with enlargement of the kidney. A clinical fact of considerable importance in connection with a tuberculous process in one kidney is the development of non-tuberculous irritative and degenerative changes in the kidney of the opposite side. I have recently seen this occurrence in two conspicuous cases, in both of which the second kidney was apparently non-tuberculous, but exhibited evidence of nephritic degeneration to such an extent as to contraindicate, in the minds of surgeons, a nephrectomy upon the tuberculous kidney of

the other side. In general, however, the existence of an irritative or even degenerative condition in the second kidney should not preclude the prompt performance of nephrectomy upon the genuinely tuberculous organ, for the reason that excision of the tuberculous focus often removes the source of secondary infection.

Symptoms.—The symptoms of renal tuberculosis are usually of insidious onset, entailing in many cases an advanced tuberculous process before recognition of the condition. Extensive destructive change limited to one kidney may take place without the exhibition of any clinical symptoms whatsoever. This is more likely to be the case when the bladder has not become secondarily affected, and when the tuberculous process does not involve the pelvis or renal tubes. In cases unattended by bladder infection, the symptoms of the kidney involvement may be altogether absent for prolonged periods. An occasional complete obliteration of one ureter may prevent a recognition of characteristic changes in the urine.

The ordinary symptoms of renal tuberculosis consist of increased frequency of urination, change in the character of the urine, pain and tenderness in the region of the kidney, with possibly attacks of renal colic, enlargement of kidney, and the coëxistence of slowly progressive constitutional symptoms.

Frequent micturition often occurs, long before the recognition of pus, blood, albumin, renal casts, or tubercle bacilli in the urine. The earliest clinical feature may consist of simple polyuria, or there may be associated symptoms of more or less bladder irritation. The desire to urinate recurs at short intervals during the night, as well as by day, and is often attended by varying degrees of pain and tenesmus.

A characteristic *change in the appearance of the urine is* sometimes the first symptom to attract the attention of the individual. The urine may be cloudy, smoky, or distinctly opaque, somewhat resembling diluted milk, though in the latter case the color is apt to be rather yellow. The cloudy or the smoky effect is produced by the presence of small quantities of pus or blood respectively. A mixed infection occasionally supervenes, the bacilluria often being due to the presence of the staphylococcus or the colon bacillus. I have under observation at the present time an exceedingly interesting case of colon bacillus infection which will be described in connection with the clinical application of the bacterial vaccines. Both the pus and blood may vary greatly in amount, in some instances being recognized only by microscopic examination. In other cases there is imparted a distinct change to the gross appearance of the urine. Hemorrhages sometimes suffice to occlude the ureter and produce intense pain, with other associated symptoms of renal colic. In some cases a sudden hematuria may be the first symptom referable to the condition. The microscopic examination of the urine easily establishes the presence or absence of pyuria, hematuria, or bacilluria. Considerable difficulty is usually encountered in the microscopic search for tubercle bacilli in the urine, but exhaustive examinations with perfected technic will demonstrate their presence in a very considerable number of cases. The smegma bacillus may be differentiated by the use of alcohol, as explained in the opening chapter.

Pain may be so slight as to attract little attention, and at other times become an exceedingly prominent symptom. The pain may consist merely of discomfort and uneasiness in the lumbar region, or it may

extend downward in the direction of Poupart's ligament. In the latter event it is usually more severe and is often accompanied by nausea and vomiting. These symptoms, in connection with intense lumbar pain radiating to the bladder, are characteristic of the passage of blood, necrotic tissue, or débris through the ureter. The pain in this locality does not always partake of an acute nature, but may appear as a dull, grinding ache or a sense of ill-defined soreness. With the development of perinephritic abscesses the pain and tenderness are confined to the region of the kidney in the costovertebral angle, and are accompanied by other manifestations suggestive of abscess formation, consisting of temperature elevations, chills, and tumor in the renal region.

In coincident vesical involvement the symptoms relate to frequent micturition, tenesmus, and pain emanating from the neck of the bladder and referred to the perineum. These are aggravated upon exertion, particularly walking, riding, or jarring of the body, and are more pronounced in the sitting than in the recumbent position. Several of my patients have complained that the pain is considerably more intense during the cold weather and whenever the surface of the body has become chilled to any extent.

An enlargement of the kidney is sometimes recognized upon palpation, but this is by no means constant. Furthermore, an increased size of one kidney, in the presence of other clinical manifestations of renal tuberculosis, does not always afford in itself positive evidence as to the organ involved, as will be explained presently.

Considerable importance attaches to the condition of the general health. There is frequently a slight elevation of temperature, with loss of appetite and general indisposition, together with more or less nervous disturbance as a cumulative result of the continued bladder irritation. A certain peevishness and irritability of temperament are noted. Sleep is much disturbed, and nutrition suffers to a moderate extent. Often tuberculous lesions in other parts of the body may be recognized upon careful examination.

The **diagnosis** of renal tuberculosis rests upon the previous history, the exhibition of symptoms just described, the results of physical examination, the discovery of tubercle bacilli in the urine, the cystoscopic examination of the bladder, *x*-ray differentiation, the segregation of urine or catheterization of ureters, and an investigation of the excretory capacity.

The previous history is of value in yielding possible data concerning antecedent tuberculous processes in other parts of the body.

Physical examination often furnishes positive information regarding tuberculous deposits in the lungs, glands, bones, joints, serous membranes, epididymis, or prostate.

It should be borne in mind that too much dependence should not be placed upon the symptoms *per se*, as other conditions, especially stone in the pelvis of the kidney, may closely simulate the clinical picture of renal tuberculosis. Again, the tuberculous character of the affection having been definitely established by urinary examination, a decision from the symptoms alone as to which kidney is diseased is not always devoid of difficulty. The likelihood of confusion relates to a possible exaggeration of the significance of pain and of enlargement. Kelly calls attention to the possibility of pain upon the unaffected side, and Meyer recites a case in point coming under his observation, the correct

selection of the kidney suitable for operation being made upon the basis of the cystoscopic findings, although complaint was constantly made of pain upon the opposite side. In the same way, even with urinary evidence of renal involvement, a non-tuberculous kidney considerably hypertrophied may become very misleading.

There is no definite relation between a *demonstration of tubercle bacilli* in the urine and a genuine renal involvement, as it has been shown that bacilli may be found in the urine of a considerable number of advanced pulmonary invalids without actual pathologic evidence of renal tuberculosis. In many cases they find their way, as previously stated, into the uriniferous tubules from the glomeruli without visible structural change. In some cases tubercle bacilli are eliminated with the urine from an infected bladder, which is known to be a frequent seat of secondary involvement. In case of a previous ascending infection from the prostate to the bladder, or from the epididymis to the prostate, the bacilli may contaminate the flow of urine despite absence of kidney disease. On the other hand, bacilli may be present in the urine as a result of actual tuberculous lesions of the renal tissues without the exhibition of clinical symptoms. Slight tuberculous processes in the kidney are occasionally subject to complete fibrous repair, and are unattended by further caseation or necrotic change. The recognition of bacilli, therefore, is insufficient to afford any accurate criterion by which to judge of the existence and degree of renal disease. The bacilli are of especial import in connection with accompanying symptoms and other methods of clinical diagnosis. It is essential to recognize a distinction between the significance of the laboratory findings and the other clinical evidences of kidney tuberculosis. In other words, the acceptance of an immediate surgical aspect of the condition should not be based alone upon the presence of bacilli in the urine.

Occasionally, the characteristic symptoms of advanced tuberculosis of this organ may exist without an early microscopic demonstration of the bacilli. Negative examinations, however, are less frequent than formerly, on account of the more careful and elaborate technic employed at the present time. Failure to discover the microörganisms upon urinary examination in cases of renal tuberculosis may often be followed by a positive result of animal inoculations. The centrifuged sediment, if injected into the peritoneal cavity of guinea-pigs, is almost always succeeded by the development of general miliary tuberculosis, which is found at autopsy after the lapse of from three to five weeks. The cytologic findings are not without some diagnostic significance, although a study of the morphologic character of the cells is seldom practised by the clinician. The presence of mononuclear cells, of course, suggests the greater possibility of finding tubercle bacilli. Colombino has noted certain important changes in the leukocytes, occurring exclusively in tuberculous infection of the genito-urinary passages. The outline is described as angular and irregular, and the cells are elongated and grooved. Sometimes the nuclei are entirely detached.

Cystoscopic examination of the bladder is of considerable importance on account of the opportunity afforded for inspecting the ureteral orifices, for noting the presence or absence of ulceration, for comparing the size of the openings upon the two sides, and observing the flow of the urine from each kidney. Decided hyperemia in the immediate vicinity of one orifice is strongly suggestive of a descending tuberculosis of the

kidney of the corresponding side. Ulcerative changes at this point, with dilatation of the mouth of the ureter, are regarded as almost pathognomonic of the condition. Kelly has referred, however, to an instance of erroneous selection of a kidney for removal, occasioned by the presence of ureteral dilatation upon the unaffected side. He also reports a rare case of primary bladder tuberculosis in which one orifice was much dilated and the other congested, without involvement of either kidney, as shown when first one and then the other was opened for suspected renal disease. Cystoscopy is often difficult of execution because of vesical irritability and contraction, but may sometimes be accomplished even in unfavorable cases, by the injection of a cocain solution.

The *use of the x-ray* is of value in facilitating diagnosis largely through the process of exclusion. By this means the presence or absence of stone may be determined with approximate accuracy. In the event of enlargement, detected upon palpation, and failure to demonstrate the bacilli, together with negative *x*-ray examination, Bevan assumes the probable condition to be simple hypernephroma.

The *segregation of urine* and *ureteral catheterization* are of the utmost importance from a diagnostic standpoint. Their value consists in part of the means presented by either method to differentiate in many cases the healthy from the affected kidney. The urine from each side may be examined with reference to its quantity, gross appearance, presence of pus, blood, bacilli, or other microörganisms. The unilateral existence of non-tuberculous irritative or degenerative change may also be detected in this manner. By the use of the Harris segregator or by catheterization there is permitted a determination of the excretory capacity of each organ. Considerable importance has been attached to the employment of elaborate methods of urinary examination after catheterization, in order to ascertain the functional power of each kidney. The supposed need of such investigation is the necessity, first, of unfailing accuracy in the selection of the diseased kidney for operation, and, secondly, of absolute certainty in the elimination of any possible involvement in the remaining organ. There can be no argument as to the force of the former, but the recognition of the diseased kidney is usually clear upon the strength of the symptoms, and special aids to diagnosis previously enumerated. It is believed by some that the existence of a slight tuberculous change or an irritative condition in one kidney is sufficient to contraindicate the performance of a nephrectomy upon the other side. A dissenting opinion is offered to the literal interpretation of such generalizing statements, although due cognizance is taken as to the wisdom of non-interference with a badly diseased kidney in the face of decided impairment of function of its fellow. The recognition of but a slight involvement, whether tuberculous or otherwise, does not invariably predicate the assumption as to the futility of surgical operation upon the kidney of the opposite side. The removal *in toto* of a considerable focus of tuberculous and sometimes of mixed infection is likely to be followed by marked improvement in the other kidney. A similar result is sometimes observed in the tuberculous process involving the bladder and prostate after nephrectomy, in cases of descending infection, or after castration, in cases of the ascending type. Freeman has referred to a case reported by Kümmel in which a badly diseased left kidney was removed in spite of coëxisting tuberculosis of the organ upon the opposite side, of the bladder, of both testicles and

both seminal vesicles, together with a tuberculous peri-urethral abscess. An immediate and pronounced improvement ensued, and the patient was enabled to return to his work.

There are three distinct methods more or less in vogue for the determination of the relative *excretory capacity* of each kidney, all involving the separate examination of the urine after catheterization or segregation. The most simple and perhaps the most accurate method is the comparison of the amount of urea excreted by the two kidneys, a diminution in the elimination of the normal amount of urea from either kidney indicating, of course, a corresponding impairment of its excretory function.

Another method is known as the *phlorizin test.* The injection of $\frac{1}{10}$ grain of phlorizin produces almost immediately an active tendency on the part of the kidney to withdraw sugar from the blood, resulting in the presence of glucose in the urine. A comparison of the amount of sugar in the urine from the respective kidneys after the administration of phlorizin, affords an approximate estimate of their relative excreting power. A normal kidney should excrete in the neighborhood of 1 per cent. A marked reduction from this amount upon the other side would indicate a considerable impairment of function.

Cryoscopy consists of a comparison of the freezing-points of the urine from the two kidneys. The test as sometimes employed includes a determination of the freezing-point of the blood, which should normally be from —0.56° C. to —0.58° C. The freezing-point of any fluid is known to vary according to differences in its specific gravity. Thus, the freezing-point is lower directly in proportion to the reduction of the specific gravity. The specific gravity of the urine, though subject to continual variation, nevertheless affords a fair estimate as to the retention of salts in the circulation. According to Morton, the practice most frequently employed in making the cryoscopic test relates to the comparison of the freezing-points of the urine taken from the right and left kidneys at the same time. He believes, first, a low freezing-point of each urine to indicate a normal excretion; secondly, a high freezing-point to suggest a diminished excretion upon each side; third, a high freezing-point upon one side and a low upon the other to demonstrate an impaired and a normal function respectively. The limitations and deficiencies of this method for general application are at once apparent.

The **prognosis** in renal tuberculosis is, of course, dependent upon the general condition, the existence of tuberculous lesions in other parts of the body, the involvement of but one or of both kidneys, and their degree of functional capacity. The course is usually slow and protracted.

The **treatment** varies according to the stage of the disease, the general health, the existence of tuberculous processes in other parts of the genito-urinary tract or in remote portions of the body, and the development of complications, as amyloid disease, nephritis, or perinephritic abscess. The latter, in all cases, calls for immediate surgical interference. Free incision is indicated in order to promote evacuation of the pus.

The rational management of renal tuberculosis may be regarded as climatic and hygienic, surgical and palliative. Sole recourse to general measures of treatment, including change of climate and judicious exercise in the open air, is obviously appropriate but to very early cases.

As a matter of fact, tuberculosis of the kidney is rarely recognized in its incipiency, and after the disease has passed this period, there exists but slight justification for delay in resorting to radical surgical operation. Procrastination at this time is met with the unanswerable argument that there is practically nothing to gain by delay, and imminent danger of descending infection to the bladder, as well as extension to the kidney of the opposite side, as shown by the comparative autopsy statistics of bilateral affection. It is true, however, that in exceptional instances satisfactory results are secured by climatic and hygienic management, suggesting the propriety of utilizing these measures for a time in cases exhibiting the earliest stage of infection. It is recognized that it may be extremely difficult to differentiate between the early cases

Fig. 126.—Posterior view. Skiagraph showing large oval tumor of left kidney of tuberculous origin. (For description of case see p. 748.)

appropriate for climatic and hygienic management, and those suited for immediate operation. It must be admitted, also, that it is in precisely this class of cases that the most satisfactory results of operative surgery upon the kidney are attained. The following considerations, however, afford a justification of occasional recourse to general measures before resorting to radical operation: the earlier recognition of the disease than formerly; the means afforded for securing a fairly accurate determination of the progress through frequent urinary examinations; the excellent results not infrequently attained by hygienic management in incipient cases; the great importance of the kidney to the vital economy, and, finally, the knowledge that even with the removal of the diseased kidney the primary focus still remains in the body and may constitute the source of future infection.

It is probable that the tubercle bacilli emulsion of Koch in properly adjusted and interspaced doses is capable of a favorable influence upon the course of the disease in some instances, and often to a remarkable degree. In the event of secondary infection a culture should be taken of the microörganisms present, and a vaccine made for inoculation purposes. The bacterial vaccine may be prepared either from the urine or from the discharge of a perinephritic abscess or both. In two cases of kidney disease recently under observation, infection with the colon bacillus was pronounced, in one instance *accompanying* a well-defined tuberculous involvement of the kidney, and in the other, closely *simulating* the latter condition. The degree of gross pathologic change incident to the tuberculous kidney is suggested in the radiograph (Fig. 126).

The operative measures relate to the performance of nephrotomy or nephrectomy.

Nephrotomy is indicated only when the conditions present are of such a nature as to contraindicate an immediate nephrectomy. In cases of mixed infection the best results are obtained by an initial nephrotomy, the more radical operation being delayed until the subsidence of the fever, and improvement in the general health. The same rule of procedure obtains in cases of great debility from any cause. Nephrotomy is also the more advisable operation, as a general rule, in the event of considerable involvement of both kidneys. The operation consists of simple incision to promote the immediate evacuation of pus and to afford subsequent drainage. The wound is left to heal by granulation, but a permanent tuberculous sinus often results.

Nephrectomy or total extirpation of the diseased kidney is the operation of choice. The best results are to be expected in the absence of other tuberculous lesions either in the genito-urinary tract or elsewhere. The presence of tuberculous deposit in the bladder, lungs, bones, and joints should not effectually preclude the operation, provided the indications for its performance are sufficiently clear upon the score of the kidneys themselves. Tuberculosis of the bladder often undergoes a remarkable improvement after nephrectomy. This may be accounted for in part by the fact that the irritability of the bladder is aggravated by a descending discharge from the diseased kidney. The expediency of nephrectomy among phthisical patients must be determined to some extent upon the basis of the pulmonary condition. If the tuberculous process in the lungs is comparatively inactive and not accompanied by extensive destructive change, the possibility of securing an eventual arrest must be admitted. In this event there should be no hesitation in according to the consumptive the benefit of nephrectomy, if indicated upon the merits of the kidney involvement. While it is true that the immediate outlook is considerably less favorable by virtue of the pulmonary complication, the fact remains that the ultimate prognosis as regards the tuberculous process in the lung is rendered much more favorable by the elimination of a large focus of infection in the kidney. The results of operation at the present time exhibit a decidedly lower mortality than in earlier years. In 1885 Gross, as quoted by Bevan, reported upon the results of 20 cases obtained from the literature, with 12 recoveries and 8 deaths. Since this time the statistics as reported by various observers show a diminishing mortality attending the operation. In 1892 the death-rate was reported to vary from 28 per cent. to 50 per

cent. The reports of Ramsay, Israel, Krönlein, Kümmel, Rumbel, Bangs, Facklan, and Garceau demonstrate more successful results, presumably from a better selection of cases and an improved technic. Garceau, in a series of 101 cases quoted from various sources, finds the mortality to be 17 per cent. Kelly reports 57 cases with 4 deaths, establishing a primary mortality of 7 per cent.

The kidney is exposed by an oblique incision extending approximately from the last rib to the crest of the ilium. Upon bringing the kidney outside of the wound the vessels are ligated with strong catgut. Considerable difference of opinion is entertained regarding the advisability of removal of the ureter if diseased. This procedure is recommended by some on account of the frequent development of fistula and lumbar abscess, with possible danger of further dissemination of the disease. It is believed by many that the ureter, even though partially diseased, should be retained because of the increased danger and extent of the operation. Tuberculous sinuses arising from this source sometimes disappear after a few months. No objection is made to the removal of a portion of a diseased ureter, and cauterization of the distal end with pure phenol when unattended by special difficulty or too great prolongation of the operation.

CHAPTER LXXII

TUBERCULOSIS OF THE BLADDER

This condition, in the great majority of instances, is secondary to tuberculous change in other parts of the genito-urinary system. It may occur as a result of either ascending or descending infection. It is probable that the larger proportion of cases of bladder tuberculosis take place as an extension from a primary lesion in one kidney. Involvement of the bladder may occur as a result of ascending infection from portions of the genital system, in accordance with Baumgarten's law regarding the flow of the secretions. It is extremely doubtful, however, if the *original* source of infection in any considerable number of cases is traceable to the external genitals. In other words, the primary infection in all portions of the genito-urinary tract is usually hematogenous rather than exogenous in origin.

Though of rare occurrence, primary tuberculosis of the bladder is sometimes observed. It must be remembered, as previously stated, that the term *primary*, as applied in this connection, refers simply to the genito-urinary tract, exclusive of infection in other parts of the body. Primary vesical tuberculosis is rather more common among females than in the opposite sex, and, according to Fournier, is occasionally due to infection from the female genitals. The pathologic changes relate essentially to the formation of small grayish nodules, which enlarge, caseate, assume a yellowish appearance, and eventually ulcerate. The ulcerations often exhibit an irregular contour on account of the coalescence of multiple tubercle deposits. They vary not only in their lateral distribution, but to some extent as well in depth. Though superficial, in many instances involving merely the mucosa or

submucosa, in exceptional cases they penetrate the vesical wall, and produce perforations into the rectum or vagina. The ulcers are usually surrounded by a zone of more or less intense hyperemia. In fact, before ulceration has taken place the only deviation from the normal macroscopic appearance may consist of reddened, irregular patches of mucous membrane.

Symptoms and Diagnosis.—The symptoms are often of slow development. They may remain unrecognized for a considerable period or they may suggest merely a varying degree of vesical irritability. Complaint is rarely made of pain in the beginning of the affection, but later this becomes a prominent symptom. Early attention is usually called to the condition by the frequency of urination. Examination of the urine at this time discloses the presence of a variable amount of pus, and sometimes of blood. The latter may be recognized as an occasional red blood-cell, or in some cases as a distinct hematuria. A few drops of clear blood may make their appearance at the end of urination. Failure to explain the bladder irritation, and the presence of blood and pus by the demonstration of stone in the bladder or of other recognized pathologic condition, suggests immediately the probability of tuberculous infection. This hypothesis is substantiated by the discovery of bacilli in the urine, although their non-recognition upon microscopic search of the sediment constitutes no negative evidence as to their presence. The diagnosis may be definitely established by a positive result of animal inoculation.

Cystoscopy, even at an early period, may yield information of almost pathognomonic character. Irregular reddened patches of mucous membrane may be recognized, which are frequently situated in the trigonum. In case of descending infection from one kidney there is usually observed, as already described, a distinct reddening and dilatation, with or without ulceration of the ureteral orifice. It may be assumed that the absence of dilatation and ulceration at the mouth of both ureters, with tuberculous nodules and ulcerations in other portions of the bladder is *prima facie* evidence that the infection is either ascending in character or primary in the bladder. Meyer reports a single instance of contraction of the ureteral orifice in tuberculosis of the corresponding kidney.

After the tuberculous lesions in the bladder undergo the process of ulceration, the general type of the symptoms assumes a greater degree of severity. The desire to urinate is more frequent and imperative. Sleep is sometimes well-nigh impossible, as the patient is awakened at brief intervals by urgent vesical discomfort. Pain is often very intense, and may be accompanied by considerable tenesmus. Though the bladder capacity often becomes much diminished, the retention of a variable amount of residual urine may take place. Incontinence sometimes occurs if the ulcerative process involves the neck of the bladder. The rapidity of the development of symptoms varies somewhat with the location of the ulcerative changes. If the trigonum is involved, the evolution of clinical manifestations is considerably more rapid than when the process does not invade this region. After ulceration has become established, a secondary infection almost inevitably supervenes, and adds to the sufferings of the patient, already sorely afflicted. Appetite and nutrition become impaired, and nervous disturbances pronounced.

Treatment.—The treatment of bladder tuberculosis is attended by much more gratifying results than in former years. In early states the management of the vesical affection itself, exclusive of the surgical indications relating to operation upon other portions of the genito-urinary tract, should be based upon the principles of nutrition and rest. As in other tuberculous conditions, the utmost importance attaches to the establishment of the best possible hygienic environment. Rest, as a rule, is more imperative than in any other tuberculous infection, although moderate exercise may sometimes be permitted if carefully supervised. The patient, in the event of suitable weather conditions, should be exposed to the open air for prolonged periods, but the fullest conception of the principles of outdoor living is capable of fulfilment only in regions where sunshine, blue skies, and an invigorating atmosphere predominate.

The climatic conditions appropriate to the successful management of pulmonary tuberculosis are those most likely to influence favorably the course of tuberculous processes in other parts of the body.

Treatment with the bacilli emulsion, or, in case of mixed infection, with other bacterial vaccines, may occasionally be attended by favorable results.

The *local* treatment of vesical tuberculosis as generally employed is most unsatisfactory. The injection of various solutions into the bladder is likely to be productive of considerable pain and discomfort. In the presence of a very acid urine, the injection of mild cleansing solutions, as boric acid, sometimes exerts temporarily a soothing effect upon the inflamed mucous membrane. The injection of iodoform suspended in olive oil has been more or less employed, with varying reports. Agents directed to the relief of the bladder symptoms should be selected not only with reference to the acuteness of the clinical manifestations, the condition of the urine, the presence or absence of mixed infection, but primarily to the stage of the tuberculous process. Nodular tuberculosis is not attended by secondary infection, and scarcely calls for local applications of any kind. Instrumentation of the bladder at this period should be absolutely avoided, as the topical solutions do not come in actual contact with the local tuberculous process, while added opportunity is afforded for the introduction of secondary microörganisms into the bladder. Unnecessary irritation is often induced, and the course of the tuberculous disease thereby hastened.

Rest and attention to the general health are of especial importance at this time. Diluents should be administered, and excesses of all kinds enjoined, especially indulgence in alcohol, coffee, or highly spiced food. Urotropin is of some utility in case of an alkaline urine, especially if bacilluria is present, although this rarely precedes ulceration unless as a result of careless catheterization. If the urine is highly acid, alkaline diuretics are indicated, to which tincture of hyoscyamus may be added in the event of extreme vesical irritability. After the ulcerative process has become established and secondary infection has supervened, considerable benefit may be obtained from the intelligent use of various strong antiseptics. Solutions of corrosive sublimate, as originally advocated by Guyon, have been quite extensively employed. Garceau recommends the early instillation of a solution of 1 : 5000 into the bladder in case of vesical tuberculosis in the female. With increasing toleration for the drug the strength is increased up to 1 : 500. If the pain

is severe an injection of cocain or eucain is advised as a preliminary procedure. He also practises the application of solid silver nitrate to the diseased surface by means of the cystoscope, with the patient in the knee-chest position. Etherization is sometimes necessary for the initial exploration and application. Tuberculous granulations are reported to have been destroyed by this method, and the process of healing decidedly stimulated. The application of silver nitrate in solution to the tuberculous bladder of males has been attended by much less favorable results. Rovsing, of Copenhagen, has obtained remarkable results by the injection of 5 per cent. solution of phenol into the bladder subsequent to cocainization.

The surgical treatment of vesical tuberculosis relates to the curetment of tuberculous ulcers, excision of portions of the bladder, and cystotomy.

Curetment is practised through a large cystoscope, and is applicable only to large active granulations covering a localized area of ulceration. If curetment is performed, it is usually necessary to cauterize the base of the ulcer with the silver nitrate. The operation is impracticable in most cases, and is attended by the disadvantage of possible further dissemination of the infection.

Excision of tuberculous ulcers, or even of a considerable portion of the wall of the bladder, has been practised in occasional instances, but the proper scope of its application is very limited. An important objection to its more general use is the fact that the ulcerative process involves with great frequency the vicinity of the ureters, in which locality excision is rarely permissible.

Cystotomy is the operation of choice on account of its comparative safety, and the immediate relief afforded to the patient, whose sufferings have been well-nigh intolerable. It is especially indicated in severe continuous bladder discomfort, with almost incessant efforts toward urination. The torture resulting from advanced tuberculosis of the bladder is almost instantly relieved by the opportunity provided for immediate evacuation of the urine.

For women the infrapubic operation is recommended by some surgeons, the vagina being regarded the natural route for drainage. It would appear, however, that while vaginal cystotomy has obvious advantages, a decided objection to its employment relates to the fact that operation through this channel is especially likely to invade the area of active tuberculous ulceration, and open up fresh avenues of infection. This objection does not obtain to the same extent in the suprapubic operation. In 1902 Dr. C. A. Powers reported a case of suprapubic drainage for advanced tuberculosis of the bladder upon a patient of Dr. S. A. Fisk, who subsequently came under my observation. As the case is somewhat unique in view of the excellent result attending the operation, extracts of Dr. Powers' report are appended. The patient was a man, fifty years of age; his wife and two daughters had died of pulmonary phthisis, and one son was the subject of existing tuberculous infection.

"The patient is of rather spare physique, who appears to be between sixty and sixty-five years of age. Examination of the chest negative. Vesical discomfort and tenesmus are urgent. He urinates every half-hour, both day and night. He takes three-quarters of a grain of morphin daily. His bladder capacity at this time is about one ounce; there

is about one-half ounce of residual urine. The urine is pale, neutral, its specific gravity 1014. It contains bacteria, bladder epithelium, mucus, and a little pus. Tubercle bacilli are sought, but not found. Cocain examination for stone is negative; the introduction of the searcher causes slight bleeding. So far as one can judge, there is no other tuberculous lesion in the genito-urinary tract."

After the lapse of two years the patient again came under observation. His condition had grown progressively worse. There was marked spasm at the neck of the bladder; urination was performed every ten minutes, day and night; hematuria was constant. Four grains of morphin were taken daily.

"He was examined under chloroform December 26, 1896. Bladder capacity, about six drams. Cystoscopic examination revealed an irregular ulcer, three-quarters of an inch in diameter, at the neck of the bladder posteriorly. This ulcer bled very easily. No stone was found. After prolonged search tubercle bacilli were found in the urine."

Permanent suprapubic drainage was performed. The bladder was found not larger than an English walnut. The wall was greatly thickened, intensely congested, and studded here and there with miliary tubercles.

"There was an irregular ulcer the size of a penny at the neck posteriorly, rather more on the left side. The ulcer was gently curetted, and its base cauterized with pure phenol. It bled pretty freely. The bladder was drawn up and its edges stitched to the skin. It seemed to resemble in size and shape the finger of a glove. The orifices of the ureters were not seen. A large drainage-tube was placed in the bladder, care being taken that its end should not touch the posterior wall, and the bladder was tightly sewn about it. The outer wound was partially closed.

"The patient was out of bed on the tenth day, and at the end of three weeks was wearing a permanent tube and urinary receptacle. At that time his morphin had been decreased to two grains daily. A month later he resumed his occupation, that of traveling auditor for a large national corporation. During the two or three months immediately following the operation there was occasionally moderate leakage about the tube. The tube itself was a soft-rubber catheter, No. 30 of the French scale, having a velvet eye at the end, as well as at the side. It was carefully adjusted and held well in place. Twice daily the patient removed and boiled the entire apparatus and washed out his bladder. His relief from suffering was marked, and he was quite comfortable. His spirits returned, he gained in flesh and strength, and was able to decrease his morphin to something less than a grain daily.

"The patient continued from year to year in a comfortable and generally satisfactory condition. At no time did I think it wise to recommend removal of the tube and closure of the fistula. I saw and examined him yearly, as once a year his business brought him to Denver for two or three weeks. I last saw him in the summer of 1901, four and one-half years after operation. At that time he was in better weight and general health than in many years. He was comfortable, except for the nuisance of the urinary fistula."

CHAPTER LXXIII

TUBERCULOSIS OF THE PROSTATE AND SEMINAL VESICLES

TUBERCULOSIS OF THE PROSTATE

Involvement of the prostate is exceedingly frequent in genito-urinary tuberculosis, and is undoubtedly more common as a primary infection than was formerly thought to be the case. It is difficult, however, to conceive of its primary involvement save upon an assumption of infection by way of the blood-channels. The mere fact of primary tuberculous disease in the prostate constitutes in itself no evidence upon which to construct a theory of exogenous infection. Some observers have been prone to regard the primary origin of the disease in this organ to result essentially from careless, unclean instrumentation and eroded mucous surfaces. This appears hardly tenable, first, because of the comparative infrequency of such a history in cases of primary prostatic tuberculosis, and, secondly, because of the mechanic obstacles offered to the retention and colonization of bacilli in the urethral canal, by the forceful washing of the urinary stream. After, however, an initial tuberculous infection of other portions of the genito-urinary system, the anatomic conditions are such as peculiarly to favor a secondary involvement of the prostate. Its situation at the intersection of the genital and urinary systems produces an increased exposure to secondary infection. In addition a tuberculous prostatic change having taken place, its location renders it a favorable point of departure of further tuberculous dissemination. It thus happens, irrespective of the primary focus, that this gland rarely escapes infection in case of urogenital tuberculosis. It is more or less immaterial, therefore, whether the disease is the result of an ascending infection from the epididymis, or of a descending involvement from the kidney or bladder, as it is well known that the prostate may be the receptacle of bacilli from either source. It is doubtful, however, if its secondary involvement occurs with frequency as a direct result of bladder tuberculosis. As between these two organs, it is probable that the disease extends from prostate to bladder much oftener than from bladder to prostate.

The **symptoms** of prostatic tuberculosis may be completely overshadowed by the manifestations of vesical disease. In such an event the diagnosis is established entirely upon the results of physical examination. In other cases, in addition to the evidences of bladder irritability previously described, there may take place from the urethra a discharge of mucus or pus, in which tubercle bacilli are found. There is sometimes present an appreciable tenderness in the perineal region, with a sense of dragging weight. Physical examination through the rectum discloses the existence of prostatic enlargement and sometimes of hard, nodular masses of varying size, which often break down and form abscesses. The size of the prostate is largely a relative matter in different individuals, and the diagnosis upon examination rests chiefly upon the prseence of the small nodular lumps which are sometimes entirely unproductive of subjective symptoms. Catheterization, however, is usually attended by considerable pain.

The **treatment** of this condition *per se* is largely climatic, hygienic, and symptomatic. If tuberculous disease exists in other parts of the genito-urinary system, the general principles of management are based essentially upon the indications presented by the other tuberculous processes. In other words, the treatment of the prostatic affection is often quite subordinate to that of infection in other regions. In case of primary involvement limited to the prostate the general management should conform to the hygienic and climatic considerations recommended for tuberculosis of the kidney and bladder. It has been demonstrated that change of surroundings and immediate environment may be attended with beneficial results. A prolonged sea voyage is often advocated for such invalids, provided other complications do not exist. It is doubtful if injections of iodoform in olive oil possess any decided advantage, though sometimes employed.

In view of the peculiar position of the prostate and the opportunities afforded for tuberculous infection in other portions of both the genital and urinary systems, the limitations and deficiencies of surgical interference are particularly unfortunate. It has been urged that the surgery of the prostate should be delayed until the indications for active interference are urgent in character. This presupposes not only that other measures have failed to produce satisfactory results, but also that *sufficient time has elapsed* for the *extension* of the disease to *other portions* of the genito-urinary tract. The propriety of excision of the prostate in case of primary tuberculous involvement prior to further bacillary dissemination is a matter for judicial surgical consideration. As there is but little technical difficulty, either to suprapubic or perineal prostatectomy, it is difficult to understand why the same rule of procedure as regards removal is not applicable to the prostate as to the kidney. It would even appear that if it is desirable to perform nephrectomy upon early cases of primary kidney tuberculosis before extension to the other kidney, bladder, and genital system, the removal of the prostate would have still wider application under similar conditions, on account of the diminished relative mortality and the lessened importance of the organ. Excision of portions of the prostate, as well as the curetment of tuberculous ulcers and sinuses, is sometimes employed.

TUBERCULOSIS OF THE SEMINAL VESICLES

Tuberculosis of the seminal vesicles rarely occurs save as a secondary extension of the disease from other portions of the genito-urinary tract. Instances of primary involvement, however, have been reported in connection with tuberculosis of the bladder and prostate, and sometimes of the epididymis. The symptoms are those of bladder or urethral irritability. There is usually marked excitability of the sexual organs, and not uncommonly, in later stages, impotence and sterility. Cameron and others have called attention to the clinical significance of the frequent emissions of blood-stained semen in such cases. I have occasionally observed this symptom among pulmonary invalids without detecting physical evidences of disease of the seminal vesicles.

The diagnosis rests upon the detection, by rectal examination, of hard, rounded protuberances in the region of the enlarged vesicle. Tuholske suggests the possibility of confusing this condition with the shot-like masses characteristic of phleboliths. He indorses the

removal of the vesicle in primary cases in accordance with Zuckerkandl's operation, which consists of a semilunar incision from the perineum with the base downward. This procedure is indorsed by many surgeons. In the event of coëxisting tuberculous involvement of the testicle and vas, necessitating their removal, as well as the seminal vesicles, a perineal incision, following the removal of the testicle and vas, may be made, through which the vesicle may be pushed from the rectum and subsequently extirpated. According to Cameron, Roux reports two such cases. Scraping or stripping of the seminal vesicle is sometimes practised, but its propriety relates almost entirely to a primary involvement. Bandet and Kendirdjy have recently reviewed 46 cases of extirpation of the seminal vesicle and vas. They regard the operation as too serious to justify its performance save in the presence of urinary fistula from tuberculosis of the vesicle, continuous enlargement of the vesicle with existence of added tubercle deposit along the vas, or rectal obstruction.

CHAPTER LXXIV

TUBERCULOSIS OF THE EPIDIDYMIS AND TESTES

Tuberculous disease of these parts originates, as a rule, in the epididymis and thence extends to the body of the testes, the vas deferens, and the seminal vesicles. The involvement of the epididymis is usually primary, though secondary infection sometimes takes place. The circulation is the almost invariable channel of infection, but it is possible that the entrance of bacilli may be permitted in rare instances through the urethra. The globus major is the part first involved in the majority of cases. Attention has been called to factors of some etiologic importance, *i. e.*, the small size and extreme tortuosity of the arteries, and the division of the spermatic into two branches in close proximity to the epididymis. Immediate continuity of structure explains the extension of the disease from the epididymis to the testes, although a tuberculous involvement of the body of the testes rarely ensues, until tubercle deposit in the epididymis has attained extensive proportions and undergone caseation. The disease is not infrequent among young adults, and is observed more commonly between the ages of twenty and forty. It sometimes exists, however, in very early life, cases having been reported even in infancy. Several observers have recorded cases occurring under one year.

The initial macroscopic pathologic change is the formation of one or more hard nodules in the globus major. These increase in size until the entire epididymis assumes the characteristics of a hard, nodular growth. The mass is irregular, knotty, and uniformly solid in the early stages. Following the period of deposit and initial hardening, a degenerative process supervenes in spots, and some of the nodules are found to have undergone caseation and softening. In such cases the skin speedily becomes adherent to the underlying tissues, and presents a peculiar glistening appearance over the site of the nodular softening. In these locations changes in color also take place. The

color may be more or less purplish from the local hyperemia, or it may assume a yellowish appearance from the abscess formation superficial to the surface, with impending rupture of the skin. Perforation is followed by the discharge of a creamy, yellowish pus, which gradually changes to a thin, cheesy exudate. These tuberculous sinuses persist, as a rule, indefinitely, though exhibiting at times an inclination toward spontaneous healing. Tuberculous involvement of the vas results in a thickening throughout its course, which is usually more pronounced at its extremities. Hydrocele is often present, but this varies according to the acuteness of onset, upon which depends, to a great extent, the character of the *clinical symptoms*.

In most cases the condition is of slow, insidious development, and the discovery of the early nodular enlargement of the epididymis entirely accidental. As the tubercle deposit assumes larger dimensions, with the formation, in the epididymis, of a tumor of wooden hardness, a frequent distinguishing characteristic of the condition is noted in the absence of pain. There often are no subjective symptoms manifested aside from the sense of weight. In these chronic cases the tuberculous process is almost always unilateral, and attended by but little, if any, tendency toward the formation of hydrocele. The enlargement, however, may progress with considerable rapidity despite the absence of inflammatory manifestations. The entire organ presents the characteristics of a solid tumor, uniformly hard in consistency, and of irregular contour, the latter being due to the presence of nodular protuberances upon the surface. When caseation and softening, however, have taken place in localized areas, palpation may disclose the sharp, crater-like, overhanging edges of the suppurating nodule. Examination at this state usually reveals the presence of tuberculous infection of the vas, the cord, and the seminal vesicles. Sinus formation is also a very important characteristic of tuberculous involvement.

An acute type of tuberculous disease of the epididymis is sometimes observed, which may or may not follow the history of trauma. It is easy to understand how slight injury to these parts may so lower the resistance of the tissues, as to bring into immediate activity an infection previously latent, precisely as has been described with reference to the bones and joints. Even in the absence of traumatism, however, tuberculosis of the epididymis may develop with acute symptoms and pursue a rapid course. In this event pain is pronounced and accompanied by a peculiar sickening sensation. An early formation of hydrocele is the rule in such cases, which is in decided contrast to the massive caseation exhibited in the more chronic type of the disease. When of more or less acute invasion and rapid development, the process is especially likely to extend to the opposite side. In such cases early abscess formation usually occurs.

Diagnosis.—An essential diagnostic consideration is the presence of tuberculous disease in other portions of the body, and especially the location of demonstrable lesions in some part of the genito-urinary system. In the absence of discoverable tuberculous change elsewhere important diagnostic data relate to the existence of a solid tumor originating in the epididymis, of peculiar hardness, irregular contour, possible localized areas of fluctuation, absence of pain, with indurated profuse nodular thickening of the vas and cord. In doubtful cases failure to respond to the specific therapeutic test is of considerable value.

Gonorrheal epididymitis may usually be excluded by the history and absence of previous discharge or pain. The localized areas of caseation and softening, with tendency to sinus formation, are distinguishing features in the differentiation from sarcoma or syphilitic gumma. The latter is especially prone to appear in the testis, while tubercle deposit usually takes place in the epididymis, before the testis.

In general the **prognosis** may be said to depend upon the health of the individual, the degree of implication of neighboring structures, and the character of the management. Speaking broadly, the prognosis should not be considered merely with reference to the future course of the tuberculous organ, but also as regards the general welfare of the patient. Judged by this latter token the prognosis must depend almost entirely upon the nature of the surgical treatment, which of necessity is contingent upon the general health. If the prognosis is unfavorable on account of advanced and extensive pulmonary tuberculosis, the local condition assumes but little importance, and may be ignored altogether in the management of the case other than in so far as pertains to palliative non-operative measures. In such conditions the rational surgical management consists merely of incision and drainage of infected softened areas. Local cleanliness must be secured as far as possible in the hope of avoiding secondary infection. Several cases among far-advanced pulmonary invalids under my observation have displayed rather remarkable improvement in the general condition after operation. I recall one patient whose condition was regarded as extremely desperate, yet subsequent incision and drainage of both testicles established a gain of fifty pounds in weight during the course of the ensuing year. Good results are sometimes obtained by iodoform applications and injections. The employment of various injections, however, into the thickened tissues prior to the stage of softening is unworthy of commendation.

Treatment.—The consideration of paramount importance in tuberculosis of the epididymis and testes relates to the expediency of castration. This alone is the practical issue in patients, whose general health is not such as to suggest a fatal termination, irrespective of the local condition. It is somewhat remarkable that many writers persist in advocating extirpation of the organ only after general and non-operative measures have proved of no avail. No more culpable error can be perpetrated than to *delay some form* of surgical interference in *young* adults with *unilateral infection*, whose pulmonary involvement is of such a character as to suggest the probability of ultimate arrest. Physicians who endeavor to avoid the responsibilities attending early excision are committing the patient to the possibility of double infection and of extension to other portions of the genito-urinary tract. It would seem almost unnecessary to argue that a broken-down testis and epididymis can be of no possible benefit to the individual, and that the immediate removal *in toto* of infected tissue is indicated upon the score of the general health. It is obvious that so large a focus of tuberculous infection as a caseated testis and epididymis must constitute a distinct *menace* to the *life* of the patient. A reasonable conclusion is to the effect that there is absolutely no justification for the long-continued nursing of the affected member. Upon the other hand, its prompt extirpation in appropriate cases provides a reasonable assurance of protection to the opposite side, and to other parts of the genito-urinary system. Through the elimination of a large tuberculous focus, added opportunities are

offered for the arrest of the pulmonary disease. In cases suitable for surgical interference it is, of course, apparent that the successful issue depends upon the *time of operation.* In early cases with the tuberculous process limited to the epididymis the total ablation of the testicle is seldom necessary. Under such circumstances excision of the epididymis, with preservation of the testicle, is the operation of choice. If the vas be found undiseased, the end may be transplanted directly into the body of the testis. In this event, even with total removal of the opposite testis, there is afforded a possible preservation of sexual and procreative ability. If, however, the vas is found to have been invaded with tuberculous deposit, it should be resected and tied as high up as possible, leaving the testis by itself in the tunical sac. This presupposes, of course, that the body of the testis presents no macroscopic appearance of tuberculous disease. The practice of total extirpation of the epididymis and testis by reason of a known involvement of the former and a presumptive invasion of the latter is subject to severe condemnation. A sweeping ablation of the testis and epididymis is far less preferable to the careful dissection of the epididymis as a preliminary procedure, even though the extirpation of the testis is later demanded. The preceding operation is admittedly more tedious, and the period of anesthesia considerably longer, but the interests of the patient are in many instances better conserved. This method of procedure is particularly applicable to cases of early involvement of the epididymis, and relates with *special emphasis* to *instances* of *bilateral disease.* It often happens that while the indications may point imperatively toward the total extirpation of the epididymis and testis upon one side, the conditions admit of at least the preservation of the testis upon the other. *Under* no *circumstances* should *double* castration be performed irrespective of the degree or extent of the pulmonary disease. I have noted several instances of greatly impaired mentality as a result of this operation. Upon the other hand, I have observed a notable illustration of the excellent results possible of attainment from the sacrifice of the tuberculous mass upon one side and the retention of the other testis, despite the removal of the epididymis and vas. The unfortunate results of epididymectomy are quite insignificant in comparison with the deplorable consequences of complete castration. The removal of the epididymis in no way lessens the influence of the internal testicular secretion upon the general health, and at the same time does not detract from the moral effect incident to the preservation of the testis. Examples of the disastrous consequences of delay in surgical interference are numerous. I will cite briefly one or two illustrative cases.

Case I.—A married man, aged thirty-two, who had been for six years the subject of pulmonary tuberculosis, consulted me early in 1907. Although the arrest of the tuberculous process in the lungs was not complete, there was exhibited, nevertheless, but little remaining pulmonary involvement. The general condition was excellent, nutrition was well maintained, and there was entire absence of cough, expectoration, or temperature elevation. Five weeks previously a small nodule had been felt in the epididymis, which rapidly increased in size. This was attended by some pain, although the recumbent position was maintained. The condition grew progressively worse until a hard, irregular, nodular mass was formed, nearly the size of

the fist, with beginning involvement of the epididymis of the opposite side. There was, however, no evidence of local softening. The patient coming under my observation at this time and objecting to surgical operation, was placed upon injections of bacilli emulsion. In addition, efforts were directed toward superalimentation. A $\frac{1}{1000}$ of a milligram of the emulsion was immediately administered, and repeated every two weeks until three injections had been given, each dose being followed by a perceptible local reaction. During the month that elapsed an appreciable improvement was noted in the general health, and a diminution in the size of the large tuberculous organ. The patient gained seven pounds in weight, local pain and tenderness entirely disappeared, without evidence of increasing involvement of the opposite side. There shortly developed, however, an abrupt change for the worse. Caseation and softening rapidly took place upon the side first involved, together with an acute hard enlargement of the epididymis upon the other. The opinion of a surgeon was rendered unequivocally as to the imperative necessity of double castration. This I strenuously opposed, and insisted upon an attempt to preserve, if possible, the body of the testis upon the side recently affected. This operation was performed by Dr. F. L. Dixon. The tissues of the left side were totally removed because of the advanced and wide-spread character of the tuberculous infection. Upon the right side the epididymis was found studded with tiny tuberculous masses, which were beginning to undergo caseation. The body of the testis was apparently uninvolved, as well as the vas. After excision of the epididymis the vas was transplanted into the body of the testis. Subsequent to the operation it was deemed expedient to administer the tuberculin in order to aid, if possible, in the preservation of the remaining testicle. This has been given weekly during the past six months, and the patient has made a *perfect recovery, sexual desire* and *potency* being *in no way diminished.*

Case II.—I have recently had under my care a man of twenty-nine years whose history of tuberculosis dates back nine years, at which time he exhibited the first evidences of an infection of the epididymis. This was permitted to remain, although extensively diseased, during a period of three years. It was then removed, but not until he had developed tuberculous involvement of the bladder and one kidney. The patient remained under my observation one year, and in addition to well-defined renal tuberculosis, has been compelled to suffer the pain and discomfort incident to advanced infection of the bladder, prostate, and seminal vesicles. His general condition was one of extreme debility, sufficient to preclude the expediency of surgical interference even were this permissible upon the score of the local conditions. There has been no evidence of pulmonary tuberculosis. The masterly delay in surgical intervention during a period of three years in a young man without evidence of pulmonary tuberculosis in this case is directly responsible for most unfortunate results, and is a striking commentary upon the fallacious teaching relative to treating patients with tuberculosis of the epididymis and testis in accordance with the principles appropriate for pulmonary tuberculosis. Conspicuous improvement has been attained in this case by the administration of the bacilli emulsion.

CHAPTER LXXV

TUBERCULOSIS OF THE FALLOPIAN TUBES, UTERUS, AND ADJACENT STRUCTURES

TUBERCULOUS involvement of the Fallopian tubes is exceedingly common. The infection of the tubes is often primary, but may take place as a result of extension from a neighboring tuberculous focus. It is probable, as stated in connection with the general etiology of tuberculosis of the genito-urinary organs, that primary involvement of the tubes occurs almost as frequently as of the epididymis, and perhaps even more often than of the prostate. The origin of the tuberculous process may be traced, in the majority of instances, to an infection conveyed by the circulation. It is uncertain to what extent the lymphatics act as carriers of the bacilli. It is possible that, in rare instances, infection may take place as a result of coitus with a tuberculous invalid. It is more than likely, however, that this manner of bacillary invasion of the female genital tract occurs but exceptionally. Admitting such possibility, however, it still remains highly improbable that a suitable lodging-place for the bacilli is afforded in the vagina, on account of the natural fortifications of this region. Protection is afforded, first, by the tough squamous epithelium, the non-eroded surface of the mucous membrane, and the profuseness of the mucous secretions, which are usually highly acid in reaction. Although tubercle bacilli are sometimes found in the vagina, a genuine tuberculous process in this region is relatively infrequent. When this does exist, it occurs almost always in conjunction with, and secondary to, tuberculosis of the Fallopian tubes, the uterus, or of both. It may be accepted as an almost universal fact that tuberculosis of the female genital system, other than the occasional existence of lupus of the external genitalia, has its primary origin in the tubes. From such point of departure secondary deposits may take place. Hare refers to the statistics of eight European pathologists in illustration of the great frequency of tuberculosis of the female genital tract. Tuberculous involvement of the genitals was found at autopsy 208 times out of 8627 cases of tuberculosis in females. According to Cornet, Kiwisch found the proportion of involvement in similar cases to be one in forty, and Cornil in one to fifty or sixty.

Tuberculous disease of these parts may exist at any time of life, though it is more frequent at the period of greatest sexual activity. Many cases of its occurrence have been reported, however, among young children. Gusserow has cited a case of tuberculous disease in the ovaries and uterus at this time of life, without implication of the tubes. Bender has collected a record of 48 cases of tuberculosis of the vulva, exhibiting ulcerative and hypertrophic lesions. Some of these were undoubtedly influenced in their development by trauma. From the statistical observations thus far reported it may be assumed that the lungs are diseased in at least one-half of the cases of genital tuberculosis, and some other portion of the urinary system in about the same proportion of cases.

The gross pathologic change in tuberculosis of the Fallopian tubes consists of a thickened, indurated condition of the wall. This is associated with a collection of cheesy pus, somewhat after the manner of

ordinary pyosalpinx. The abscess formation takes place almost always at some point in the tube more or less remote from either extremity. The fimbriated end usually becomes thickened and adherent to the ovary or the peritoneum, producing a permanent occlusion of the lumen. Obliteration of the canal often takes place also at its proximal end, and this suffices in many cases to prevent the escape of infected cheesy detritus into the uterus. The intervening portion of the tube is usually somewhat dilated, and in some cases becomes the seat of miliary nodules. In the event of uterine infection, the tuberculous process commonly begins in the vicinity of the tubal orifices, the cervix seldom being involved. Tuberculosis of the uterus has been regarded in the past as a very rare condition, but is undoubtedly somewhat more frequent than was formerly supposed. The process makes its first appearance in the endometrium, which becomes infiltrated with tubercle deposit. Caseation, softening, and coalescence of these lesions produce an ulcerative endometritis in the discharge of which tubercle bacilli are sometimes found. The disease may extend from the distal end of the tube to the ovary or peritoneum. The former may become studded with tuberculous nodules or break down into an abscess cavity. Evidences of localized peritonitis sometimes follow the invasion of the serous membrane in the immediate neighborhood of the fimbriated end of the tube.

The **symptoms** of tuberculosis of the tube in some cases do not differ from those of ordinary catarrhal salpingitis, but there may be in other instances characteristic evidences of pyosalpinx. The condition is usually bilateral. Upon palpation alone it is difficult to differentiate tuberculosis of the tube from other pathologic conditions producing tumor in this region.

The symptoms of tuberculosis of the uterus are not especially dissimilar to those of non-tuberculous endometritis. There may be temperature elevation and evidence of moderate septic infection, with, usually, tenderness and some enlargement. The character of the involvement is suggested by the recognition of tuberculous disease in other parts of the body, and confirmed by the detection of tubercle bacilli in the uterine discharge. In the event of a negative history of tuberculosis and failure to discover an infection in other regions, the nature of the involvement may be disclosed by the presence of bacilli in the discharge, or by a microscopic examination of the uterine mucosa removed by the curet.

In the absence of active and extensive pulmonary disease, the prognosis depends upon the early recognition of the condition and the adoption of prompt surgical measures. The diagnosis once established, there should be no delay in operative interference among patients whose general condition does not contraindicate surgical aid.

The **treatment** is purely surgical, and consists of vaginal hysterectomy, with removal of tubes and ovary if infected.

It is important, even in woman, to ascertain conclusively in regard to the condition of the kidneys and urinary tract in cases of genital tuberculosis. Kelly has recently called attention to the rather surprising association between renal tuberculosis and a similar involvement of the tubes and uterus. The treatment of lesions involving the external genitals is that of free and wide excision, or tentative recourse to tuberculin injection.

SECTION VIII

TUBERCULOSIS OF THE SKIN AND UPPER RESPIRATORY TRACT

CHAPTER LXXVI

TUBERCULOSIS OF THE SKIN

GENUINE tuberculous involvement of the cutaneous tissue is rare among phthisical patients, but nevertheless of exceeding interest. Tuberculous lesions of the skin occur among individuals otherwise healthy, but some of the clinical varieties are found with greater frequency among patients suffering from tubercle deposit in other parts of the body. Illustrative of this, is the well-known relation of the ulcerative form of *tuberculosis cutis* to infective processes in the nasal cavities and to lesions of the genito-urinary tract. The uniform proximity of certain types of tuberculous skin lesions to the mucous orifices, viz., of the mouth, nose, vagina, and rectum, is presumptive evidence of an *infection derived* from these *respective avenues*, despite the absence of demonstrable tuberculous processes in parts tributary to the openings.

Other clinical forms of cutaneous tuberculosis suggest a source of infection from *without* the body, either as a result of contagion or accidental inoculation. This is especially true of the verrucous type of skin infection, the *verruca necrogenica*, or so-called anatomic wart, the *verruca cutis*, believed by many to be identical with the preceding, and, lastly, *lupus verrucosa*.

Still other varieties owe their origin to *contiguity of structure*, particularly the *scrofuloderma*, which results by extension from adjacent tuberculous glands or an underlying infection.

Finally, the local condition may arise from a *dissemination* of the infection through the *circulation*, the integument becoming affected as a result of the conveyance of bacilli from some internal focus. It is likely that certain forms of lupus originate in this manner, and particularly the *tuberculosis disseminata*.

Waiving for the time being any discussion regarding the clinical aspects of these types of cutaneous tuberculosis, attention is directed to the *rôle of the skin as a channel for tuberculous infection*. This is perhaps of greater scientific interest than the local manifestations of the tuberculous condition. It is to be remembered that a localized tuberculosis of the integument affords no evidence in favor of the skin as a port of entry for the initial tuberculous invasion. Local processes, however, may be expected to attend an entrance of the infection through the skin. It has been claimed by some observers that whenever the skin constitutes the avenue of infection, the tuberculous deposit is *confined* to the integument, and remains a distinctly localized process. This is unsupported by clinical data, although in many instances the advance of the bacilli is arrested by the proximal lymphatic glands. The virulence of the infection following inoculation is usually slight.

Its progress in the lymphatic channels is more or less obstructed, and the evolution of tuberculous lesions of the skin exceedingly slow. The difficult genesis of cutaneous tuberculosis is explained by the unfavorable character of the soil. The thickened epithelium, especially in certain localities, offers a protective barrier against tuberculous infection, even though exposure be excessive and long continued. Further, the temperature is usually insufficient for the growth of bacilli, even in the event of direct inoculation into the subcutaneous tissue. After the actual development of tuberculous skin lesions the number of bacilli are few in comparison with similar processes in the internal organs.

In 1898 Baldwin demonstrated the presence of living tubercle bacilli upon the hands of pulmonary invalids. He poured over the palmar surface of the fingers from 5 to 10 c.c. of a sterilized 1 per cent. solution of $NaCO_2$, using sterilized plain glass finger-bowls as receptacles. The washings were inoculated into guinea-pigs, with a positive result in 10 out of 15 cases. Tubercle bacilli were also found in the microscopic examination of the centrifuged sediment in 2 cases. Somewhat similar results had been obtained by Cornet in the previous year. In connection with these experiments it is interesting to consider the much greater exposure of the lips. Important considerations are the lessened protection arising from the relative delicacy of the tissues, the common existence of fissures upon the mucous surface, and yet the infrequency of local lesions among a class of people compelled daily to expectorate enormous numbers of bacilli. Even in this location resulting lesions, if present, are almost always indolent.

There are recorded numerous instances of the limitation of the tuberculous process upon the hands following contamination with infected material and accidental inoculation. Even after introduction directly into the subcutaneous tissues, the infective material is usually discharged by suppuration, or the resulting tumor disappears by resolution without clinical evidences of further infection. The resistance to infection by the skin is also demonstrated by experiments upon the lower animals.

It is well to refer to some of the clinical and experimental data upon which is based the assumption of a definite localization of the tuberculous process, either upon the integument or at most in the proximal lymphatic glands. The evidence as to the comparatively innocuous character of the infection relates—(1) To the development of lesions upon the hands of individuals after exposure by contact with tuberculous meat; (2) similar processes involving the skin of pathologists following postmortem examinations of human and animal subjects; (3) instances of accidental penetration of the bacilli through the skin of those thrown into close association with consumptives, or accustomed to handle infectious sputum; (4) the attempted cutaneous inoculation of animals with subcutaneous or intraperitoneal injections in control animals; (5) ineffective inoculation of unfortunates suffering from malignant non-operable disease. These several considerations may be briefly discussed seriatim.

The infection of the hands after exposure to contact with tuberculous meat is always a strictly localized condition. Lozzar, in 1903, exhibited a number of such cases, in which there had taken place no extension of the tuberculous process beyond the point of infection, although the

local lesions had existed for many years. If it be assumed that general dissemination of the infection takes place from the site of inoculation in such cases, it must follow that butchers, before the days of meat inspection, would have shown a relatively high mortality rate from tuberculosis. This has not been demonstrated to be the case. Von Ruck has called attention to the observations of Heilburg, who reported an average of 618 butchers in Copenhagen with but 25 deaths from tuberculosis during a period of ten years.

During recent years numerous instances have been reported of an apparently benign local infection following small abrasions of the skin, or accidental injury during autopsy upon man and animals. A conspicuous example of the non-virulent character of such local infection is found in the experience of Laënnec, who suffered an accidental inoculation while performing an autopsy, and survived twenty years, though finally dying of phthisis attributed by some to the original local invasion. Gerber's case is also of interest. Following an autopsy wound, and in spite of immediate disinfection, a "Leichen" tubercle the size of a cherry developed at the site of the injury, and persisted for months. Shortly after excision of the nodule the axillary glands became involved, and when extirpated were found to contain tubercle bacilli and to present characteristic tissue changes. There were no evidences of further tuberculous extension.

Many isolated cases of injury during autopsy upon consumptives could be cited to support the contention, made by the advocates of a limited benign tuberculous process, that the infection is either confined to the site of inoculation or is arrested by the nearest lymphatic glands. Extension by means of the lymphatics is more frequent in case of the anatomic wart following autopsy upon the human subject, than in association with the local lesions upon the hands of those exposed to contact with tuberculous meat, viz., the verruca cutis described by Riehl and Paltauf.

Accidental inoculation occasionally results from autopsies upon tuberculous cows, and cases have been reported of this occurrence without secondary extension of the infection. Ravenel has cited four cases of local tuberculous change following a skin wound upon the hands of veterinarians during postmortem examination. In no instance was there an extension of the process even to the nearest lymphatic glands, although the growth of the nodule at the seat of inoculation was very rapid in one or two cases, suggesting a decided virulence of the infection. In the first case reported the diagnosis was based upon the clinical history and the histologic lesions, bacilli not being demonstrated in the sections. In the second case the local lesion developed at the expiration of three weeks after injury. The nodule was excised two months after the initial skin abrasion, and two guinea-pigs were inoculated subcutaneously, with positive results. In the third case the local process developed at the expiration of nearly four weeks after the accident. The nodule was excised at the end of six weeks, and tubercle bacilli were found in the sections. In his report of the fourth case local symptoms were described as appearing in about four weeks, with a well-developed nodule within six weeks. Two guinea-pigs inoculated with portions of the nodule developed generalized tuberculosis, and tubercle bacilli were found upon examination of other portions of the growth. Tscherning has reported a case of accidental injury to the hands of a

veterinary surgeon occurring at autopsy. The process was essentially local, though attended by slight extension through the lymphatics. Ravenel has referred to the experience of Mueller, who describes two cases of injury to the fingers resulting during work upon tuberculous cattle. In each case the synovial sheath of a tendon was opened. After operation there was found a distinct tuberculous deposit upon the wall of the sheath, and upon the tendon in immediate proximity to the site of the wound, in one case extending not over a distance of 10 centimeters, and in the other merging into the forearm. Ravenel further alludes to one case observed by de Jong, and to two reported by Joseph and Trautman, in all of which the tuberculous lesion resulted from injury received while at work upon tuberculous cows, and was confined to the point of inoculation in each instance. A similar case is reported by Braquehaye.

Penetration of the skin of individuals by tubercle bacilli of human origin is not uncommon as a result of accidental injury. Numerous cases of such inoculation have been observed among nurses, attendants, relatives, and domestics thrown into close association with pulmonary invalids and with tuberculous products. According to Cornet, cases have been reported by Tscherning, Merklen, Lesser, and Holst, in which the wound was received through contact with a broken edge of a cuspidor or glass sputum cup, the local process being followed by involvement of the lymphatic glands.

I have under observation at the present time a case which presents features of unusual interest. The patient is a woman of forty-five years who has been employed as a servant during the past ten years in a large and well-known institution for consumptives. Throughout this entire period her work has consisted of the very frequent handling of cuspidors. Some three years ago she developed an advanced tuberculous tenosynovitis or compound ganglion at the front of the right wrist. This extended down the sheaths of the tendons of the little and index fingers nearly to the tips. A physician recently opened the swelling at the middle of the little finger, squeezing out the so-called rice-bodies. From day to day more or less of these were expressed. The little finger became infected through the wound, and the infection spread up the sheath of the tendon to the general bursa at the front of the wrist and thence to the index tendon. In view of the acute septic manifestations which supervened, it was necessary to amputate the little finger, to excise its flexor tendon, and to lay open and drain the compound ganglion itself, as well as the sheath of the index flexors. Diligent attention by Dr. Powers saved the hand proper.

Instances of local infection are reported by Cornet to have taken place as the result of a bite by a consumptive (Vercheré, Jeanselme, Leloir). Other cases of accidental injury of various kinds, with subsequent local lesions, are recorded among attendants upon consumptives and even among pulmonary invalids themselves. Local cutaneous tuberculosis is found occasionally among laundresses accustomed to handle the linen of consumptives. It has been known to result from the piercing of ears and the wearing of infected earrings. Czerny is authority for two cases resulting from skin-grafting. Ulcerative tuberculous lesions, especially of the face, are not infrequently traced to slight abrasions of the skin in consumptives or others exposed to an obvious source of infection. In occasional instances the same is true

of the external genitals. Under such circumstances lupoid changes have supervened at the site of unhealed sores, incised or punctured wounds, and almost all forms of excoriation upon the skin, including eczematous and vaccination surfaces.

Animal experimentation has also been instructive in determining the rôle of the skin as a port of entry of general tuberculous infection. Calves, sheep, swine, goats, and guinea-pigs were made the subject of investigation by Chaveau, Günther, Horner, and Bollinger in former years. Laboratory experiments conducted upon animals in the effort to produce a cutaneous inoculation with highly virulent human bacilli were frequently unsuccessful. In like manner negative results have followed similar attempts to infect these animals by means of subcutaneous or intraperitoneal inoculations, with the single exception of the guinea-pig, which is the most susceptible of the entire animal species. Bollinger was unable to produce infection through the skin of the guinea-pig in a series of six experiments, but was successful in the *sub*-cutaneous injections of the control animals. Baumgarten, in 1901, reported work done in his institute by Gaiser in connection with experiments upon calves with human tubercle bacilli. It was found that after subcutaneous injections of large numbers of bacilli from pure culture, the point of inoculation remained almost without reaction, and when the animals were killed, several months later, no trace of tuberculous change existed in any part of the body. These results closely conformed to those obtained by Koch, who inoculated young cattle with pure cultures of tubercle bacilli taken from human beings without discovering subsequent symptoms of disease or the slightest evidence at autopsy of pathologic change. A somewhat doubtful result of inoculation experiment was reported by de Schweinitz, Dorset, and Schroeder. A heifer was inoculated with a portion of lung and intestine from a human subject dead of miliary tuberculosis. After six months an autopsy was performed and a small abscess found at the point of injection. Tuberculous involvement of proximal lymphatic glands was discovered, and indeterminate growths upon the pleura and diaphragm.

The *relation* of *human* to *bovine* tuberculosis *necessarily involved* in these and other experiments has been discussed at some length, hence further reference to this relationship will be made as brief as possible.

Previous to the investigations of Koch and Baumgarten, Rokitansky had endeavored in vain to produce an infection in human beings suffering from incurable disease. Bovine tubercle bacilli were employed in these ineffective inoculations because they had been found highly virulent for rabbits, and were supposed to be identical with the type of microorganisms derived from human tuberculosis. After a dozen trials without resulting infection the experiment was abandoned, and no attempts of a similar character, as far as I have been able to ascertain, have been repeated.

The foregoing considerations comprise a portion of the evidence which, from time to time, has been regarded as sufficient to justify the belief in a cutaneous infection which is almost invariably localized and benign. Ravenel, in his contention for the intercommunicability of bovine and human tuberculosis, explains the innocuous character of the lesions produced by accidental inoculation with bovine tubercle bacilli, by assuming an equally benign local process resulting from infection with human bacilli. This again introduces the question of

differences between these two varieties of bacilli, and also suggests the presentation of data to disprove a frequent limitation of the tuberculous process at the site of inoculation, *irrespective* of the *special* type of tubercle bacilli. Attention is, therefore, directed once more to the cutaneous lesions appearing upon the hands, derived from tuberculous meat and the cadavers of man and animals, or from inoculation with infected material through contact with tuberculous sputum, and also to different experiments upon animals with the human and bovine bacilli.

The verrucous variety of tuberculous lesions of the skin may be accepted as the most frequent manifestation of the local infection. Admittedly this form of cutaneous tuberculosis is rarely accompanied by evidence of lymphatic involvement, although *superficial* extension does take place in many instances. The process, though insignificant at first, may spread rapidly upon the surface of the integument from the point of invasion until several inches are embraced within the diseased area. The necrogenic wart, the common form of autopsy lesion, though more localized in the cutaneous tissues than the verrucous type, is more often accompanied by secondary extension, and sometimes even by grave systemic infection. A case in point is the recent observation by Ransome (Walsham), concerning the development of acute symptoms following an injury to the left hand of a physician while performing an autopsy upon a child who had died of tuberculous peritonitis. Six days later the temperature rose to 103° F., and a small localized pneumonic consolidation was detected at the base of the left lung. Shortly afterward the left axillary glands exhibited evidence of invasion. Two weeks after the injury the swelling of glands, together with the constitutional disturbance, was sufficient to demand measures for surgical relief. After incision the pus was found to contain tubercle bacilli, and was infective to guinea-pigs in three weeks. Cases of secondary involvement of glands, pulmonary infection, and finally death have been reported by Verneuil, Vercheré, Pich, and Pfeiffer (Cornet). I am personally cognizant of a similar case of autopsy infection to which a former colleague succumbed.

The physician, previously in robust health, suffered a slight injury to the thumb from the breaking of a slide while examining tuberculous sputum. There shortly developed a sore upon the thumb, characteristic of the verrucous form of cutaneous tuberculosis. Amputation of the thumb was advised, but refused. In spite of involvement of the proximal lymphatic glands, the sore healed in from a month to six weeks. After a few months an idiopathic pleurisy developed, which subsequently proved to be of tuberculous nature. He died of pulmonary tuberculosis in two years from the time of the injury.

It is possible that such cases would be more numerous were it not for the protection afforded by the bleeding, and the prompt measures toward disinfection. Deneke has recorded a case of localized cutaneous tuberculosis, followed by infection of the cervical lymphatics and death in a child. The injury was occasioned from a broken jar used by a tuberculous mother. Instances of a fatal termination from accidental inoculation with bovine bacilli are also recorded. Hartzell reported the development of the verrucous type of cutaneous lesion, followed by death from pulmonary tuberculosis within one year. Pfeiffer has related the case of a veterinary surgeon, who exhibited a definitely localized

tuberculosis of the cutaneous tissues, yet who succumbed to consumption at the end of one and one-half years after the injury. Ravenel has cited the death of Mr. Thomas Walley, Principal of the Royal Veterinary College of Edinburgh, as a probable instance of infection received during autopsy upon a tuberculous cow.

The experiments upon animals by Baumgarten and Koch, which have been described, were accompanied by similar inoculation of calves, swine, asses, sheep, and goats with the use of bovine bacilli. In the first calf infected by Baumgarten, death took place within six weeks from general miliary tuberculosis attended with great emaciation and dyspnea. The investigations of Koch with bovine bacilli yielded almost identical results. Injections of tubercle bacilli taken from the lungs of cattle with advanced pulmonary tuberculosis were made subcutaneously. After a brief period there developed high fever and progressive emaciation. Many died after the lapse of one or two months. At autopsy, characteristic changes were found not only at the site of inoculation, but also in the lymphatic glands, lungs, spleen, omentum, and peritoneum.

Since the report of these early experiments much investigation of a similar nature has been conducted by European and American observers. It has been pointed out, in connection with the relation of human and bovine tuberculosis, that tubercle bacilli of human origin have been found in many instances to be virulently infective to animals. It is apparent, from a review of the foregoing, that the evidence relating to cutaneous infection is more or less conflicting. It is safe to assume, however, that inoculation with tuberculous material is much more frequent than commonly supposed and likely to be attended by serious consequences. It is probable that the danger of infection through the skin is greater from tubercle bacilli of human origin than from the bovine variety. The rôle of the skin as an avenue of tuberculous infection should not be dismissed as of trifling significance, although this was formerly believed to be the case.

The relation of tuberculous lesions of the skin to the existence of infective processes in other parts of the body is of considerable importance. Among my own patients I have been unable to procure sufficient data as to the comparative frequency of cutaneous tuberculosis *among consumptives* to hazard even an approximate opinion upon this subject. My experience has been confined to the observation of a class of patients outside of free dispensaries and charitable institutions and, therefore, would hardly reflect a correct estimate of the actual proportion of such cases. It is well known that the cutaneous lesions are more common among the ignorant and uncleanly, on account of the much greater opportunity for infection. Among my private cases of pulmonary tuberculosis, however, numbering in excess of two thousand, I recall but two instances of lupus, one appearing upon the forehead and one over the sternum, and a single ulcerative tuberculous process upon the female genitals. Upon the other hand, the evidence is conclusive regarding the frequency of pulmonary involvement among the victims of cutaneous tuberculosis. Bender made inquiry in 159 cases of lupus, and found existing tuberculosis elsewhere in 77 cases, and a history of previous involvement in 22 others. Fox, in a class of 96 hospital cases of his own, reported 33 instances of glandular involvement. Among 144 cases cited by Bloch, 114 exhibited other evidence of tuberculous

infection. Sachs reported 115 patients, among whom only 15 failed to present a history of hereditary infection or of active tuberculous disease (Stelwagon). Of 66 cases of lupus reported by the same observer, all of whom exhibited evidence of tuberculous infection in other regions, 36 were definitely tuberculous before the development of lupus. Besnier records 8 cases of pulmonary tuberculosis among a total of 38 suffering from lupus, and Leloir, 98 out of a total of 312 (Cornet). A lessened resistance of the tissues to bacillary invasion, and added means of infection either from without, as a result of accidental inoculation, or from contiguity of diseased structures, constitute ample explanation of the greater prevalence of cutaneous lesions among individuals afflicted with other forms of tuberculosis.

Variations in the clinical manifestations and in the character of the pathologic change in the several forms of skin tuberculosis are believed to be due largely to essential differences in the nature of the infective agents. Besnier, Leloir, and Tavernier regard a secondary infection as the chief etiologic factor in the development of tuberculous *ulcers*, and the inoculation of tubercle bacilli alone as the determining feature in the production of the *verrucous* forms. According to Stelwagon, they differentiate, in the various phases of lupus, between a neoplastic and a suppurative process, the former being ascribed to the irritative action of the tubercle bacillus, and the latter to the presence of the staphylococcus aureus. Wright is of the opinion that all cases of suppurative lupus are associated with a staphylococcic infection, and that especially aggravated cases of lupus exhibit invariably a streptococcic infection.

The tuberculous character of the cutaneous lesions has been demonstrated by the presence of the bacilli, their growth in pure culture, the results of animal experimentation, and the tuberculin test. Such an array of testimony regarding the nature of the condition appears for clinical purposes to be quite sufficient, despite the dictum of Virchow that the presence of a true pathologic tubercle is the sole determining factor in genuine tuberculosis. He discriminated between a bacteriologic and a pathologic tubercle, the latter being a cellular organization, developed from the tissues of the host, though stimulated originally by the irritative effect of tubercle bacilli. He emphasized the essential formative or productive element of the *cells*, which is not inherent to the bacilli alone. Judged solely by this token, it is difficult to reconcile the structure of certain forms of bacillary skin invasion, viz., the verrucous types, lupus vulgaris, and the ulcerative lesions, with true tuberculosis. The anatomic structure of scrofuloderma, however, is closely analogous to that of tuberculosis of other organs, the subcutaneous tissue being the seat of small round-cell proliferation, with epithelioid cells and occasionally giant-cells. As degeneration progresses ulceration finally takes place through the superficial layers of epidermis. On account of the divergence in the pathologic and histologic structure of lupus from tuberculous processes elsewhere, it has been suggested that the lesions were produced by two different types of tubercle bacilli, though possessing the same morphologic and biologic characteristics, but this view is not entertained to any extent at present. Reference has been made to the hypothesis advanced by Smith and others that the various recognized differences between the several types of tubercle bacilli may be attributable in part to a change in the host, and that the same organism ulti-

Fig. 2.—Scrofulous form of skin tuberculosis, same patient as in preceding illustration. Marked reduction in size of cervical gland and healing of superficial ulceration as result of four months' treatment with bacilli emulsion. Note the less reddened appearance of the ulceration and the thin healing edges.

Fig. 1.—The scrofulous type of skin tuberculosis in a patient exhibiting a well-defined caseous gland of the neck. Note the red, glistening appearance of the ulcerative area, its irregular contour, and superficial aspect. Compare with following illustration.

mately undergoes certain modifications through its selective adaptation and environment. The histologic features of lupus, though by no means identical with those of true pathologic tubercle, yet in connection with the presence of the bacilli are sufficiently similar to justify its inclusion in the same general category. As compared with the classic tubercle of Virchow, there are a less number of epithelioid cells and a proportionate increase in the number of giant-cells. According to Bowen, there are an increased vascularity and a greater proliferation of connective tissue. The giant-cell is also found in gummatous deposits and other granulomata. Degenerative changes take place, but are of insidious onset and slow development, owing to the comparatively small number of bacilli. For the same reason connective-tissue hyperplasia is permitted to a greater extent than in true pathologic tubercle, a cicatrix often being formed, sometimes of hypertrophic variety. In the verrucous form the chief distinctive characteristic of the neoplasm, as opposed to the papillary variety of lupus, is the location of the growth in the upper layers, rather than in the middle and lower portions of the corium.

The clinical appearance, diagnosis, prognosis, and treatment of the various forms of cutaneous tuberculosis involve considerations of so purely technical nature as to preclude the propriety of their introduction in a work devoted to pulmonary tuberculosis. As a possible complication of this condition, however, a brief résumé of the more important features is perhaps permissible.

Varieties.—The ordinary *verrucous variety* has been described in the preceding pages as possessing a tendency to extend superficially, often invading several inches upon the dorsal aspect of the hand. The spread of the infection may be such as to involve the fingers and entire digital folds, sometimes the wrists, but rarely the palms. The peripheral extension may produce a coalescence of several discrete patches, with a resulting irregular outline. The infected region presents the appearance of wart-like projections arising from an infiltrated reddened or purplish area. The nodules may be fairly discrete, or aggregated in close apposition to each other. Upon the summit of the papillary vegetation very small pustules are sometimes found. The affection is of slow growth, and exhibits a decidedly sluggish course, there being almost never a tendency to ulcerate. It may last indefinitely, or disappear without obvious reason.

The *necrogenic wart* is a single, isolated papillary formation, without tendency toward ulceration or extensive peripheral spread. It may occur upon any portion of the dorsum of the hand, though observed more commonly in the region of a joint. It increases in size very slowly, sometimes attaining a growth of over one inch in diameter, which is, in fact, considerably in excess of its ordinary proportions. The appearance is that of an irregular, hard, warty excrescence, which is somewhat flattened and reddened. In some cases a slight pus-formation is present, with associated small pustular crusts. The course is slow, and the duration of the lesion indefinite, though spontaneous healing may occasionally take place.

The *ulcerative form* of cutaneous tuberculosis relates to the initial presence of tiny miliary tubercles and their subsequent caseation, softening, and ulceration. As previously stated, this variety is found in proximity to the mucous orifices, especially the mouth, nose, anus,

and external genitals. It is observed almost exclusively among subjects of pulmonary tuberculosis, and is directly occasioned by the infected mucous discharge, together with an added susceptibility of tissues. Lesions within the mucous channels are usually demonstrable. The ulcers, as a rule, are superficial and irregular, with soft edges. The floor is rarely smooth, but presents slight granulating projections of an indolent appearance, with scanty secretion and dirty reddish color.

The disseminated form of skin tuberculosis is observed too rarely to warrant more than passing allusion. This condition is often acute in type, and consists of the eruption of diffused lesions of a multiform nature. The process is scattered upon almost any portion of the body, and may resemble a variety of cutaneous affections. It occurs, however, in conjunction with a recognized tuberculous infection in other regions.

The *scrofulous type* of ulceration occurs particularly in connection with contiguous caseating and suppurating lymphatic glands. The initial involvement of the skin is manifested by the dull red and glistening appearance, which is observed over the site of the enlarged gland soon after the process of softening has been established. The distended skin soon undergoes one or more minute points of degeneration, which become the openings of small sinuses connecting with the infected glands. These ulcerative orifices assume larger proportions and the adjacent skin is broken down throughout an increasing area. An ulcer is formed which may attain the size of a plum. The most frequent site is over the cervical glands, but similar lesions may appear in portions of the body remote from and irrespective of lymphatic enlargement. The ulcerative process displays but slight tendency to progress deeply, but may exhibit a gradual lateral spread. There is but little infiltration of the outlying tissues. The edges are thin, dully reddened, and sometimes slightly undermined, the contour irregular, and the floor superficial without marked vegetating granulations. The course is slow and disappointing. This variety of cutaneous tuberculosis is occasionally observed in children in conjunction with other tuberculous processes. (See plate 13.)

Lupus vulgaris, as previously stated, consists of a definite structural formation in the deeper portion of the corium, closely analogous to that of true pathologic tubercle. In addition to the tubercle formation, essential characteristics are the retrogressive changes, ulceration, healing with cicatrization, and the insidious development of new lesions by peripheral extension. The early manifestations are the appearance of macules or papules of a dull red color, followed by the formation of a patch of agglomerated nodular tubercles. Degeneration of the infiltrated portions takes place, and in turn is succeeded by a shallow indolent ulceration. A slight secretion of a purulent nature is usually present. Crusts appear from time to time and remain for a variable period unless subject to active treatment. Healing often takes place with the formation of scar tissue. New areas become affected either along the borders of the infiltrated region, or even at the site of the cicatrix resulting from the initial lesion. The patient with lupus of the forehead presented the history of a rapid appearance of new foci in the same region, despite a complete previous healing of the process. Under *x*-ray treatment cicatrization was again induced. The location of the lupus in this case, and the appearance of the lesion before the *x*-ray treatment was instituted, is shown in plate 14, figure 1. The present condition is shown in

FIG. 1.

FIG. 2.

Fig. 1.—Lupus vulgaris of the forehead of several years' duration. Note irregular distribution, nodular appearance, the shallow ulceration, and crusts.

Fig. 2.—Area of cicatrization in case of lupus vulgaris of the forehead after healing has taken place. Same patient as preceding. Note faint pinkish discoloration.

plate 14, figure 2, from a recent painting after cicatrization had become complete. In plate 15 is shown the appearance of another lupus, involving the anterior surface of the chest, of many years' duration. The nodular character of the lesions in this case was especially marked, as was the tendency to bleed upon manipulation.

The face is the usual site of the disease, especially the region of the nose, but it may occur in any part of the body. Variations from the common type of the lesion are exemplified in the hypertrophic, sclerotic, papillomatous, serpiginous, and edematous forms, the nature of which is characterized by their respective names. Lupus is associated, as a rule, with no evidence of constitutional disturbance. The course is protracted and invariably disappointing, the periods of improvement alternating with those of comparatively rapid progression. The condition may be stationary or quiescent for prolonged periods.

Diagnosis.—The more important difficulties in the way of diagnosis of the various forms of cutaneous tuberculosis attach to the differentiation of lupus vulgaris from epithelioma and syphilis. Epithelioma is usually a disease of later years, and is not associated with a history of tuberculosis elsewhere. The ulceration arises from a sharply localized spot, the previous condition being that of an apparently benign mole, wart, or incrustation. The destructive change, as a rule, is less superficial, is more rapid, attended with greater loss of substance, and rarely manifests any tendency toward spontaneous healing.

Syphilis is more difficult of accurate differentiation, especially if the lesion appears upon the face. It is much more frequent than lupus, and hence more likely, in case of reasonable doubt, to be the cause of the cutaneous affection. The history of the patient is of considerable value, but not of paramount importance. An emphatic denial of early syphilis is not entitled to absolute credence. A negative result in the effort to elicit an admission of a previous *specific manifestation* is of more consequence. The existence or history of pulmonary tuberculosis is inconclusive, inasmuch as syphilis, like lupus, may occasionally occur in conjunction with tuberculous processes in other parts of the body. As with epithelioma, syphilis of the face, except initial lesions, is more likely to appear in later life than lupus. The course of the disease is considerably more rapid in syphilis than in lupus, the ulcerations are usually deeper, and attended by a more profuse secretion. Stelwagon calls attention to the darker, more coppery-red color of the syphilitic lesions in contrast to the brownish yellow or red of lupus. The configuration of the cutaneous affection is also more irregular and eccentric in syphilis. On account of the paucity of tubercle bacilli in the infected area, the results of microscopic examination of the secretion and of animal inoculation in lupus are more or less untrustworthy. Tuberculin injections and the ophthalmotuberculin test are of undoubted value, and should be resorted to in obscure cases, especially after failure to secure improvement from antisyphilitic medication. It is known, however, that a positive reaction from tuberculin injections may occasionally take place in cases of pure syphilitic infection.

The **prognosis** of lupus is at best uncertain. Much depends, of course, upon the general condition and the extent of tuberculous processes in other parts of the body. The personal equation is also a most important factor, as most patients, on account of the slow and unsatisfactory progress and the frequent renewed exacerbations fol-

lowing an apparent recovery, become exceedingly difficult to manage. Thus the individuality of the patient and of the physician assumes a degree of inportance in the character of ultimate results. In general, it may be stated that if the involved area is not too extensive before active medical interference is instituted, fairly satisfactory progress toward securing cicatrization may be maintained. The process of recovery is, however, tedious to a degree, and demands the exercise of great patience, perseverance, and intelligence, qualities not always attributable to this class of patients. The disease is commonly regarded as less virulent in this country than abroad.

Treatment.—The rational management of lupus, as of other varieties of cutaneous tuberculosis, involves the adoption of both constitutional and local measures. The general health must be conserved and encouraged in all instances. Precisely as in other forms of tuberculosis, it is the individual as well as the local condition that appeals to the medical attendant for advisory and supervisory attention. The treatment of the general condition is perhaps no less important than in pulmonary tuberculosis, and includes the consideration of such therapeutic agents as climatic change, hygienic surroundings, and appropriate medication. The general management should be based upon the same principles of nutrition, sunshine, and outdoor life as have been described in connection with tuberculosis of the glands, bones, joints, and the genito-urinary system. Medicinal therapeutics comprise the administration of the various tonic and constructive remedies, aids to digestion and preparations directed to the relief of special disturbances. In addition, definite benefit may sometimes be expected from the employment of the tubercle bacilli emulsion in carefully adjusted doses. In ulcerative forms due to the presence of staphylococcic infection a homologous vaccine made from a pure staphylococcic culture should offer satisfying results in occasional instances. In former years, under the use of the old tuberculin of Koch, rapid healing was induced in many cases, but the relapses were frequent and sudden, and the method was gradually abandoned.

The local management embraces the use of topical applications of a soothing or destructive nature, the *x*-ray or the concentrated light of Finsen, and operative measures. The number of local applications recommended by various dermatologists under the several conditions presented is almost infinite. Their enumeration, as well as the description of the technic of the operative methods, belong strictly within the domain of dermatology or general surgery. The procedure usually adopted is that of curetment and scarification. Excellent results have been reported to attend the use of the Finsen light. The *x*-rays are of undoubted benefit in many cases.

CHAPTER LXXVII

TUBERCULOSIS OF THE LARYNX

This condition is undoubtedly the most frequent complication of pulmonary tuberculosis. Statistical observations as to the proportion of cases of laryngeal involvement among consumptives are more or

Lupus vulgaris involving the anterior surface of the chest, of many years' duration, in a woman sixty-five years of age. Note especially the marked protuberance over the center of the sternum, the characteristic smaller nodules, the crusts, blood-clots, and marginal healing.

less divergent. Bosworth, from an analysis of a large number of collated cases, concludes that tuberculosis of the larynx exists in about one-third of all cases of pulmonary phthisis. He believes, however, that from a clinical standpoint, the number exhibiting subjective symptoms do not exceed 13 per cent., as previously stated by Willigk. According to Thompson, the pathologic statistics from the Brompton Consumption Hospital demonstrated an actual tuberculous involvement of the larynx in 50 per cent. of all cases of consumption coming to autopsy. Cornet has referred to the statistics of several observers, who reported as follows: Kruse, 16.6 per cent. out of 742 cases of consumption; Gaul, 25.7 per cent. out of 424 cases; Eichhorst, 28.1 per cent. out of 462 autopsies; Heinze, 30.6 per cent. out of 1236 autopsies; de Lamallerie, 44.2 per cent. out of 502 cases.

In connection with these analyses it is important to call attention to the essentially different conditions obtaining in the computation of statistics based upon the autopsy findings, and those founded purely upon clinical observation. In the former the patients had succumbed to an exhausting disease of a tuberculous nature, abundant opportunity for secondary infection having been provided through overwhelming exposure and absence of tissue resistance. In the other cases the clinical evidence relates to the exhibition of subjective and objective signs among individuals in all stages of pulmonary disease, in many of whom the process is undergoing arrest. Obviously, there is afforded but little opportunity for comparison. It is manifestly improper to state that because approximately one-third of all tuberculous subjects at autopsy exhibit laryngeal disease, a similar ratio must exist among pulmonary invalids as a class. One author has assumed that inasmuch as 50 per cent. of the autopsies upon pulmonary invalids at the Brompton Hospital in London showed pathologic changes in the larynx, and as 70,000 people die annually in England from consumption, it must follow that 35,000 sufferers from laryngeal tuberculosis succumb each year in the United Kingdom, and not less than 75,000, "upon the statistics of averages," who are at present afflicted with the disease. Others have gone so far as to indulge in the sophistry that if laryngeal tuberculosis affects nearly one-half of all consumptives, and if pulmonary tuberculosis comprises one-seventh of all deaths, then about one-fourteenth of the population must suffer from tuberculosis of the larynx. As a matter of fact, the clinical manifestations of laryngeal tuberculosis are not as frequent among pulmonary invalids as the pathologic findings at autopsy would indicate. Further, it should be borne in mind that the *laryngeal involvement* may in some cases be quite devoid of clinical significance and remain a *feature entirely subordinate* to the pulmonary affection. In a considerable number of cases, however, the laryngeal disturbance assumes a prominence sufficient to overshadow all other considerations. Among pulmonary invalids, on account of the coëxistence of a considerable variety of non-tuberculous laryngeal lesions, it is easy to understand how there may arise radically differing statistical observations. Schrötter reported laryngeal tuberculosis in 6 and 8 per cent. of his cases of pulmonary consumption, while McKenzie recognized its existence in 33 per cent. of such cases. Chronic catarrh of the larynx, though of frequent occurrence among phthisical patients, and predisposing more or less to the development of a local tuberculous infection, is unworthy of inclusion among cases of laryngeal tuberculosis.

Etiology.—Tuberculosis of the larynx may be primary or secondary, but, in the great majority of instances, its secondary character is established. Many clinicians have been led to question the existence of a primary infection, but the evidence that such occasionally takes place appears incontrovertible.

There came under my observation, in the early part of 1907, a young man who arrived in Colorado three months after the recognition of a tuberculous infection. There was very pronounced hoarseness and slight cough with expectoration. A loss of twenty pounds in weight was exhibited, but there had been no temperature elevation. Upon examination there was a complete absence of the physical evidences of pulmonary infection, but the sputum was found to contain innumerable tubercle bacilli as well as the microörganisms of mixed infection. Examination showed the interior of the larynx to be purplish red with irregular, slightly nodular infiltration of both vocal bands. The subglottic infiltration was covered with hemorrhagic spots, and the arytenoids were swollen and red. The infiltration upon the left side was more marked than upon the right. It is quite unwarrantable to assume the existence of a primary infection simply upon the basis of a negative physical examination of the chest. The possibility of failure to detect the presence of a small tuberculous focus in the lungs should be fully recognized. In connection, however, with the absence of other clinical evidences of pulmonary disease, and in view of the positive conclusions derived by several pathologists with reference to the possibility of primary laryngeal tuberculosis, it is reasonable, in this case, to question a pulmonary infection prior to the detection of physical signs or the development of laryngeal lesions.

In general authentic evidence of primary laryngeal tuberculosis can be obtained only through recourse to the postmortem findings. Massucci reported several cases of primary laryngeal tuberculosis without the discovery of pulmonary lesions at autopsy. Orth has recorded a single instance of similar character. Demme has described a case of laryngeal tuberculosis in a child four and one-half years old, who died of tuberculous meningitis, and in whom the pulmonary tissues were unaffected. Numerous cases have been recorded by observers illustrating the greatly delayed pulmonary involvement following an apparently primary laryngeal infection. It is not uncommon to detect eventually the characteristic signs of pulmonary infection among individuals in whom the evidences of tuberculous involvement were at first confined to the larynx. The clinical recognition, however, of tuberculous processes in the lung after the lapse of many months subsequent to well-defined laryngeal tuberculosis, does not in itself refute the assumption of a primary infection of the larynx.

It is true that, in general, tuberculosis of the larynx either accompanies or occurs as a later complication of pulmonary consumption. The infection in some cases is probably produced as a result of the passage and retention of bacilli-laden sputum. The peculiarities of anatomic construction of the interior of the larynx are such as to afford especial opportunity for the lodgment of tiny masses of sputum. The complexity of structure of the many parts of the larynx, the variety of affections, the almost unceasing movements in respiration, vocalization, coughing, and deglutition, the irregular disposition of the mucous membrane in intralaryngeal folds, and its intimate attachment to

underlying tissues, all combine to favor a secondary infection in a region traversed frequently by the bacilli. Not only are unusual facilities offered for the hospitable reception of bacilli, but the local structures are subject to constant irritation by reflex excitability and trauma. Cornet has called attention to the fact that the stagnating sputum permitted to remain in various portions of the larynx is usually retained in close proximity to a joint, and in such position that with the normal movements of the larynx a massage-like motion is imparted.

Infection also takes place occasionally through the circulation. This method of bacillary transmission to the larynx occurs largely as a local instance of a general miliary invasion. The process is usually more or less acute in type, and is attended by other manifestations suggestive of the systemic involvement. As to whether or not local infection may result through the medium of the vascular channels *other* than in general miliary tuberculosis, opinions differ widely. Some assert that the location of the tuberculous process in the subepithelial tissue and the scant number of bacilli toward the epithelial surface are *a priori* evidence that the invasion took place from within. This basis of reasoning, however, is unsupported by the accumulated evidence of many observers, who have demonstrated the passage of bacilli through an intact mucous membrane in various parts of the body. Further, irrespective of the larynx, the infiltrative process is known to be more active in the deeper tissues of the various organs. Therefore, the universal predilection of the bacilli for the subepithelial portion, even if true, would afford no argument against direct infection through the epithelial surface of the mucous membrane. Tubercle bacilli have been found, moreover, in large numbers, upon the surface of laryngeal ulcers. In the case of apparent primary tuberculosis of the larynx previously cited, without pulmonary signs, the sputum expelled in the act of clearing the throat was peppered with bacilli, although the process in the larynx remained essentially superficial.

If the fact of hematogenous infection be denied, save in cases of general miliary tuberculosis, it is difficult to explain satisfactorily the development of laryngeal involvement prior to pulmonary infection, save upon the assumption of extension from a concealed focus through the lymphatics. Such method of development involves necessarily the previous existence of some neighboring tuberculous focus, which, if *incapable* of demonstration at autopsy, suggests the *possibility* of inhalation infection in *some* cases of primary laryngeal involvement. The testimony thus far adduced as to this possibility is by no means convincing. The demonstration of tubercle bacilli, in the nostrils of nurses and attendants in sanatoria, as well as in the tonsillar crypts and adenoid growths of children, would afford *prima facie* evidence of their entrance into the larynx of mouth-breathers. In cases of primary tuberculosis of the larynx a consideration in favor of an inhalation infection is the fact, to which allusion has been made, that in laryngeal invasion occurring as a local manifestation of general miliary tuberculosis, the process is acute, displaying a somewhat uniform, bilateral involvement, with the tissues more or less edematous. If this be true in the event of hematogenous infection attending a general systemic invasion, it may be questioned why it should not also be the case if infection occurs through the medium of the vascular channels without a general miliary tuberculosis. It so happens, however, that cases of

primary laryngeal tuberculosis do not exhibit the characteristic appearance, nor manifest the typical course, obtaining in general miliary infection. In the former the lesions are usually unilateral at first, of slow development, and chronic course. The assumption appears tenable, therefore, that in cases of primary involvement the source of infection is not invariably attributable to the circulàtion.

An attempt has been made by some observers to demonstrate, in cases of secondary laryngeal involvement, an especial predilection to tuberculous infection upon the side corresponding to the pulmonary disease. This has failed of substantiation in almost all instances, though Schrötter claims, out of 114 autopsies, to have found this relation in 74. It is difficult to explain such phenomena upon the basis of any physiologic data. It would seem that a rational explanation of a unilateral disturbance of *function* within the larynx is offered by compression of the recurrent laryngeal nerve as a result of pleural thickening or enlarged mediastinal glands. A noteworthy instance of the latter is found in the case reported upon page 427. It is impossible, however, to reconcile in this manner a corresponding unilateral tubercle deposit in the larynx. I have had occasion many times to observe an active laryngeal tuberculosis confined to the side *opposite* the pulmonary infection. A conspicuous example has come under observation and is illustrated by the drawing, Fig. 129, which shows the *initial* tubercle deposit to have involved the left side of the epiglottis. In this case the early symptoms referable to a tuberculous process developed with hoarseness in 1887. For several years the patient remained under the continuous observation of expert laryngologists in this country, as well as abroad. On account of the badly ulcerated condition of the left side of the epiglottis, amputation of the left half was performed. The physical evidences of pulmonary involvement were confined entirely to the upper portion of the right lung.

The **pathologic condition** consists of superficial ulceration, infiltration, deeper ulceration, and tuberculous new-growths. One or all of these conditions may be present in the same larynx. In the majority of cases infiltration is the earliest manifestation of pathologic change. The most frequent site of tuberculous lesions is the region of the arytenoids and the interarytenoid commissure. Lake reported this portion of the larynx affected twice as often as the vocal cords, and about three times as often as the epiglottis and ventricular bands (Thompson). In striking contrast is the experience of Gaul, who reports, out of 113 cases, an involvement of the arytenoids in less than two-thirds as many cases as of the vocal cords, and in but little more than one-half the number affecting the epiglottis (Cornet). The consensus report of many laryngologists, however, indicates the preponderance of arytenoid involvement, and the comparative infrequency of epiglottidean affection. Levy in 1889 reported, out of 144 recorded cases, lesions of the epiglottis in but 41. My own observation, in a general way, concerning the location of tuberculous processes in the larynx among pulmonary invalids, points toward an apparent predilection of the infection for the region of the arytenoids. In Figs. 127 and 128 are shown drawings of the laryngeal conditions in two patients recently under observation. I have noticed repeatedly that cases of pronounced epiglottidean invasion were those of general miliary infection, especially if the local process

was accompanied by more or less edema. In such cases there were often recognized small miliary tubercles scattered over the crescentic surface. Fig. 130 represents a drawing of the larynx of a patient who succumbed to general miliary infection.

While infiltration usually precedes other pathologic changes, it may be associated with the formation of papillomatous growths, and finally with varying degrees of ulceration. I have been impressed with the

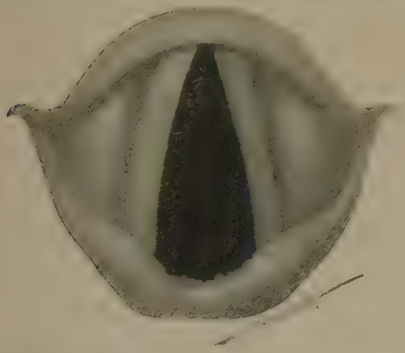


Fig. 127.—Nodular tuberculous infiltration, posterior commissure.

Fig. 128.—Tuberculous infiltration of vocal bands and posterior commissure.

great frequency of small cauliflower excrescences within the interarytenoid commissure among phthisical patients, as well as in others exhibiting no evidence of tuberculous infection. Tubercle bacilli are sometimes found at the base of the papillomata after curetment.

The tuberculous process within the larynx is often complicated by varying degrees of mixed infection. In the case of primary disease

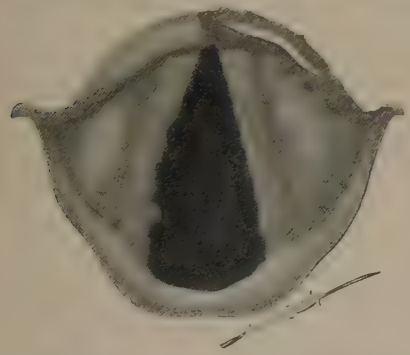


Fig. 129.—Scar of tuberculous ulceration, left half of epiglottis, nodular infiltration upon vocal and ventricular bands.

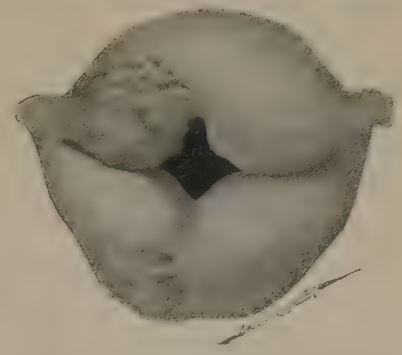


Fig. 130.—Tuberculous edema, epiglottis, arvepiglottic folds, and arytenoids, with nodular ulcerations.

previously cited, the secondary infection was pronounced, consisting of many varieties of microörganisms, the staphylococcus and the streptococcus predominating. In this connection it is of interest to consider the possibility of secondary involvement of the lung, and the development therein of local non-tuberculous processes, as a result of extension from the larynx. The downward bacillary distribution may relate to the bacteria of mixed infection, as well as to tubercle bacilli. It has

become a matter of common clinical observation, as stated, that an apparent primary tuberculous deposit in the larynx is followed after a variable time by the appearance of pulmonary lesions. Apropos of a possible aspiration infection in the lung, the following case is perhaps worthy of brief report:

A boy, thirteen years of age, the patient of Dr. Robert Levy, Dr. Henry Sewall, and myself, was brought to Colorado in February, 1906, presenting a history of hoarseness of one year's duration. An utterly hopeless prognosis was rendered on the strength of an advanced laryngeal infection. The larynx was found to present the ulcerative stage of tuberculous involvement, and the chest to exhibit signs of definite consolidation from the apex to the third rib of the right lung, with fine clicks at the end of inspiration following a cough. The afternoon temperature averaged in the neighborhood of 103° F. The amount of expectoration for twenty-four hours was from three to four ounces. Despite the tuberculous character of the laryngeal disturbance and the pronounced physical signs, the sputum was found to contain no tubercle bacilli after exhaustive examination, but pneumococci were present in large numbers. The case is of interest as illustrating the possible primary infection of the larynx, which, through the dysphagia induced, and the consequent aspiration of particles of food, became responsible for the subsequent development of a pulmonary infection of pneumococcic origin.

The **subjective symptoms** of tuberculosis of the larynx consist essentially of varying degrees of hoarseness and dysphagia. To these may be added an increased sensitiveness, which is manifested by efforts to clear the throat and by an added tendency to cough. A not infrequent symptom is pain, extending to the ears and aggravated upon swallowing. This is often noted early in the development of ulceration.

While the hoarseness and dysphagia constitute the most prominent symptoms, the former being one of the earliest manifestations of the disease, many cases exhibit considerable tuberculous change within the larynx prior to the development of any subjective symptoms whatever. A routine examination of the larynx should be conducted from time to time despite entire absence of suggestive symptoms. In this connection it is important to bear in mind the anatomic causes of the voice impairment and of the dysphagia.

Impairment of voice takes place as a result of imperfect coaptation of the vocal cords, through involvement of the crico-arytenoid articulation, thus interfering with normal tension and producing deficient abduction and adduction. Imperfect approximation of the cords may also result from the presence of papillomatous growths in the interarytenoid commissure. Irrespective of the *movements* of the cords, the voice may be impaired by thickening and ulceration of their free margins. Dysphagia, on the other hand, is produced by ulceration along the free edge of the epiglottis and in the aryepiglottic folds. Only in the presence of this condition is the pain upon swallowing actually acute. Difficult swallowing, with sometimes a moderate sensation of pain, is experienced in case of extensive infiltration and ulceration of the arytenoids. The onset of laryngeal dysphagia is indeed a most distressing symptom, and may also occur as a result of ulceration of the epiglottis from any cause. I have under observation at present a woman in advanced pulmonary phthisis, who suffers considerable dysphagia

and dyspnea from the presence of a tuberculous tumor in the right half of the larynx, involving the right vocal band and the right ventricular band.

A considerable involvement of certain parts of the larynx may exist without the production of subjective symptoms. This is particularly true of moderate changes in the ventricular bands and arytenoids. The hoarseness may begin as a slight change in the quality or timber of the voice, and extend to the point of complete aphonia. Aside from this impairment of the vocal sounds, a certain huskiness or interference with normal phonation may result from the presence of large quantities of mucus. It is especially noticeable among patients afflicted with epiglottidean swelling, and is sometimes associated with frequent efforts to expel clear mucus of a viscid and often ropy consistency. It is possible that the peculiar character of the voice in such cases may be partly occasioned by the encroachment of the edematous epiglottis into the normal air-chamber, thus interfering with the sound vibrations and modifying their quality.

The dysphagia may vary from a sense of uneasiness during the act of swallowing to the most acute suffering. In case of advanced ulceration and immobility of the epiglottis, regurgitation of liquids often takes place through the nostrils. It often happens that patients are able to swallow semisolids when liquids are rejected. Owing to the swelling of the epiglottis, the aryepiglottic folds and the arytenoids, together with the faulty muscular action from infiltration, the larynx is not sufficiently protected during the act of deglutition. Thus liquids having less cohesive property than semisolids readily find their way into the larynx at this time.

In the event of severe dysphagia a degree of relief may be secured by taking food through a tube with the head lower than the shoulders. This procedure may be undertaken with the patient reclining over the edge of the bed, the head being downward. The same principle applies in such cases as obtains at the time of administration of food following the performance of intubation in laryngeal diphtheria.

Patients are able to swallow more easily with the head lower than the body, because of the fact that in this position the food is not permitted to gravitate into the larynx.

A detailed description of the **local appearances,** revealed upon laryngoscopic examination, is scarcely appropriate in a book devoted to pulmonary tuberculosis, but the visual conditions are so characteristic, as a rule, that a brief allusion to the more important features is in order. Even before the development of infiltration or of superficial ulceration, typical changes are observed in the color of the mucous membrane, especially within the interior of the larynx. The lining mucous membrane is more or less pale or yellow in appearance, in place of the normal pink. The blanching of the membranes may persist in some cases for almost indefinite periods without infiltration or ulceration. Usually, however, minute yellowish, opaque spots show through the superficial epithelial surface. Following a somewhat slow process of softening and disintegration, small points of ulceration are observed, which eventually coalesce and form ulcers of varying size but of shallow depth. Meanwhile localized infiltration frequently takes place in the arytenoids, which are transformed into rounded or club-shaped swellings. While one arytenoid is usually more infiltrated than its fellow, it is

somewhat exceptional for the tuberculous process to be definitely unilateral as regards this particular region. The papillomatous excrescences previously mentioned are easily recognized in the posterior arytenoid commissure during abduction, only to disappear from view in the act of phonation. For a time the cords may continue to present a normal appearance, but in many cases they exhibit a thickening and congestion, with here and there a tiny ulcer upon the free edge. Indentations may subsequently form, or the cords may become partially obliterated as the result of marginal extension of the initial ulcerative points. With the commencement of epiglottic involvement authorities are wont to describe a symmetric edematous swelling, giving rise to a so-called "turban-shaped epiglottis," frequently studded with small deposits of miliary tubercle. This laryngoscopic image is certainly pathognomonic of *one* variety of epiglottidean tuberculosis, which has been referred to as especially likely to accompany a general miliary involvement. There is often noted, however, a marked difference in the distinguishing characteristics of tuberculosis of this region. In the first place, the edema or infiltrative process may be strictly unilateral. There are, moreover, many cases of tuberculosis of the epiglottis which are not associated with tumefaction and congestion, with the formation of miliary tubercles, or even with points of active ulceration. I refer to instances, often observed, of a pale, anemic epiglottis, the crescentic margin of which is somewhat irregular, with a peculiar localized notching, at which points the process may perhaps be described as a crumbling, non-inflammatory disintegration. Although considerable deformity sometimes results, the condition is usually attended by no subjective manifestations. In advanced cases of laryngeal tuberculosis, the contour of the interior is greatly altered, and extensive areas are involved by the ulcerative processes. It is often difficult to distinguish between the ulcerative and infiltrative regions, owing to the close similarity of their appearance.

I am cognizant of the many deficiencies of the foregoing description of the visual appearances in laryngeal tuberculosis, but have endeavored in few words to present the subject from the standpoint of an internist, rather than to aspire to an elaborate exposition, from a laryngologic point of view. For this reason no attempt will be made to introduce elements of differential diagnosis between tuberculosis, syphilis, lupus, perichondritis, and malignant growths, as these considerations pertain not to the complications of pulmonary tuberculosis, but strictly to the domain of laryngology.

The **prognosis** of laryngeal tuberculosis is a matter concerning which clinicians in health-resorts are enabled to form in general fairly definite opinions. There has been observed of late among writers a tendency to indulge in more or less generalization concerning this subject. One very prominent author, from his own experience and that of others, has recently asserted that the average duration of life following the onset of pulmonary tuberculosis is three years, and the period after the development of a complicating tuberculosis of the larynx, one and one-half years. It must be apparent that each case of laryngeal tuberculosis, like the pulmonary infection, must necessarily be a law strictly unto itself. Each individual instance of this complication, in accordance with the widely differing conditions in force, must be judged solely upon its own intrinsic merits. I have been privi-

leged to observe very many cases entirely recover in the hands of my colleagues, to whom such patients were referred for local treatment. In other cases I have been forced to witness a speedy termination in a suprisingly short time after the development of the laryngeal condition. Furthermore, a few patients have been observed, in whom recovery took place spontaneously, the improvement in the laryngeal affection developing *pari passu* with the gain in the general condition. Heryng has reported fourteen cases in which the healing was spontaneous.

The prognosis of tuberculosis of the larynx may be assumed to vary according to the state of the general health; the extent and degree of activity of the pulmonary infection; the tendency toward tissue repair, as shown by the previous history; the location, duration, and character of the laryngeal process; the nature of the general supervisory control; the skill and experience of the laryngologist; and the personal equation of the patient as regards temperamental peculiarities. Before rendering an opinion as to the probable outcome, all the phases of the individual case should receive thoughtful consideration. The important bearing of the general health and of the condition of the lungs upon the ultimate prognosis is too obvious to warrant explanation. The *situation* of the *tuberculous lesion* is of considerable significance as regards its amenability to arrest and the degree of resulting functional disturbance. Generally speaking, a tuberculous deposit *within* the larynx is possessed of much less direful import than attaches to involvement of the arytenoids, and particularly of the epiglottis. Even permanent impairment of the voice, resulting from extensive destructive change involving the cords and ventricular bands, is assuredly attended by less disastrous consequences than follow the development of dysphagia. Aside, however, from the purely functional incapacity, an infection upon the *exterior* of the larynx is more likely to be of rapid progress than *within*, and is more frequently an accompaniment of a general miliary invasion. Tuberculous processes upon the ventricular bands are usually slow. Perhaps the one factor of especial prognostic moment favoring recovery is improvement in the general condition.

Treatment.—The management of laryngeal tuberculosis must be primarily directed toward a restoration of the strength and powers of resistance. It is questionable if, in a very considerable number of cases, this feature of treatment should not take precedence over the employment of local applications. Any desire to reflect upon the utility of local treatment, for properly selected cases in the hands of competent laryngologists, is emphatically disclaimed. It is contended, merely, that not every case of laryngeal tuberculosis is suitable for local therapeusis. In some patients the nature of the tuberculous process is not such as to demand other than local cleanliness, which can be maintained at home under proper instructions. In others, the character and extent of the underlying pulmonary affection, with the accompanying temperature elevation and exhaustion, are sufficient to preclude attention to the larynx, unless means to conduct the treatment are improvised in the home. Even among patients whose general condition is admittedly less desperate, unfortunate results often attend the effort involved in seeking throat treatment at a point necessarily remote from one's place of temporary abode. It is probable that some patients do not secure results at all commensurate with the expenditure of energy, the nervous excitement, the interruption of the outdoor

régime, the frequent accession of fever, and acceleration of pulse consequent upon the journey to the office of the laryngologist. There can be no doubt as to the correctness of the preceding assertion, even among invalids for whom local management is actually indicated upon the merits of the *laryngologic* condition. Under such circumstances it necessarily becomes a choice of the lesser of two evils, the decision as to the method of procedure demanding a wise discrimination upon the part of an experienced clinician.

There can be no argument as to the propriety of local management in cases of ulcerative laryngeal involvement among individuals whose general condition does not contraindicate the effort required to secure the treatment. Nothing can be more pitiful, however, than to witness advanced and hopeless consumptives dragging themselves to a doctor's office day after day to receive a few moments of laryngologic attention, no matter how skilful or rational the treatment.

It is not within the scope of this book to enter into the details of local treatment applicable to the manifold conditions present in laryngeal tuberculosis, and, therefore, but a cursory discussion of the general principles is appropriate. The determination of the particular form of local treatment to be accorded individual cases is entirely beyond the province of the internist. The conservative judgment of the experienced laryngologist as to methods of application is of far greater value than dexterity of manipulation. In general, alkaline cleansing solutions are indicated for any variety of tuberculous lesions. Solutions of cocain and eucain are of value in case of painful deglutition, or as a preliminary to the introduction of other preparations. Levy frequently uses preparations of menthol which are antiseptic, anesthetic, and stimulant. He describes their effect "in relieving the pain, diminishing the cough, and giving the patient a feeling of general well-being." Ulcerative processes are variously treated by applications of iodoform, aristol, lactic acid, nitrate of silver, and occasionally by the careful use of the curet. Cohen has cautioned against the use of lactic acid unless the mucous membrane is broken, but he believes it to be of especial value in case of superficial ulceration. It should not be used in excess of 80 per cent. strength, and usually in considerably weaker solutions. Its efficacy depends upon the thoroughness of its application, which involves a degree of rubbing or massage. Dr. J. M. Foster prefers a 2 to 8 per cent. aqueous solution of formaldehyd, which is to be thoroughly rubbed into the ulcers. For the technic of the several procedures, together with their special indications, the reader is referred to text-books upon laryngology. In dismissing the subject of laryngeal tuberculosis attention is again called to the paramount importance of general management. The same principles of climatic, hygienic, and constitutional treatment apply as in tuberculosis of glands, bones, joints, genito-urinary organs, and other regions already described. It should be noted, however, that laryngeal tuberculosis, more than all other complications, is apt to be associated with considerable pulmonary involvement and a varying degree of functional derangement, systemic infection, and exhaustion. For these reasons rest, as opposed to exercise, should be emphatically enjoined. Sunshine, fresh air, and superalimentation are demanded even more rigidly than in other forms of local tuberculosis. Favorable climatic influences are of special benefit on account of the improved nutrition afforded, the increased facilities

for outdoor exercise, and the psychic effect of changed environment. A tendency has been observed to decry the advantages of climate for invalids suffering from any form of laryngeal tuberculosis. As a matter of fact, however, if the general condition and the pulmonary infection are such as to suggest the propriety of climatic change, the existence of a laryngeal tuberculous deposit only intensifies the necessity of prompt action. Any therapeutic agent known to exert a favorable influence upon the course of the pulmonary disease may be expected to exercise a corresponding effect upon the local condition. The existence, therefore, of vulnerable tissues within the larynx, in association with pulmonary tuberculosis, in the absence of special contraindications, accentuates the wisdom of early climatic change.

CHAPTER LXXVIII

TUBERCULOSIS OF THE EAR AND NOSE

The frequency of purulent otitis media among pulmonary invalids is a matter of common clinical observation. The tuberculous nature of the affection is demonstrated by the presence of bacilli in the secretion and by the results of autopsy, the latter having disclosed tubercle deposit in the membrana tympanum, the middle ear, and even the inner ear. According to James, Wingrave found true tubercle bacilli in the purulent discharge of 17 patients with middle-ear disease out of a total of 100, and pseudotubercle bacilli in 7 cases.

There appears to be no fixed relation between the activity or extent of the pulmonary process and the development of tuberculous disease in the ear. It is generally believed, however, that the otitis is more prone to occur among advanced consumptives, and to be relatively infrequent during early stages of pulmonary disease. As a matter of fact, tuberculosis of the ear is comparatively rare as a clinical manifestation among rapidly progressive cases of pulmonary tuberculosis, but, upon the contrary, develops somewhat more frequently among chronic invalids in whom the pulmonary process is more or less stationary. It should not be assumed that the aural affection rarely supervenes during periods of general or pulmonary improvement, nor that a previous otitis media invariably undergoes a corresponding change for the better at such a time, after the manner of laryngeal tuberculosis. It is not uncommon, even among consumptives who have attained a moderate degree of improvement in the general condition, with an apparent quiescence of the tuberculous infection. I have had occasion to note its occurrence not infrequently among cases of the fibroid type, and it has appeared in some cases after a complete arrest of the pulmonary infection has been secured. Several patients have presented the history of a purulent discharge of a demonstrably tuberculous nature as the first manifestation of tubercle deposit.

In view of the preceding observations, it is reasonable to question to what extent the disease of the ear is dependent upon the pulmonary infection *per se*. Unusual facilities are presented among consumptives

for the extension of the tuberculous infection to the middle ear, the Eustachian tubes constituting the medium of bacillary transmission. The orifices of the tubes are subject to almost continuous exposure to infection, on account of the frequent passage of sputum to the pharynx, and the forced distribution of bacilli to neighboring regions by violent expulsive cough. Masses of infected sputum frequently become adherent to the posterior wall of the pharynx, and remain for prolonged periods. This is also true of the nasopharynx, particularly with the patient in the recumbent posture during sleep. Cornet has referred to the statement of Dmochowski concerning the difficult detachment of bacilli after their deposit upon the projectile lips of the Eustachian orifices, and to the opinion of Haberman that the tubes are wider in consumptives, by reason of the greater absorption of fat and tissues. There also exist among pulmonary invalids certain other exciting and aggravating causes of bacillary extension to the middle ear. The acts of coughing and sneezing, vomiting and retching, so common among this class of patients, provide a means of ready communication to the ear through a patulous tube. In this connection the thought is suggested that the violent paroxysmal cough, frequently observed among cases of the fibroid or bronchitic types, is at least a partial explanation of the surprising development of ear tuberculosis in patients otherwise maintaining a degree of improvement.

The conveyance of tuberculous infection to the ear through the tympanum by the introduction of contaminated fingers and a multitude of miscellaneous articles, as claimed by various authors, although accepted as a most remote possibility, is of but slight practical interest. There are, however, other sources of infection of undoubted importance exclusive of the existence of pulmonary tuberculosis. Purulent otitis media is a not infrequent sequel or accompaniment of cervical adenitis in children. In the discussion of glandular tuberculosis it was pointed out that involvement of the cervical glands was often due to an infection traceable to the nose, mouth, pharynx, or tonsils. The development, therefore, of tuberculosis of the glands of the neck simultaneously with that of the middle ear, in the absence of pulmonary disease, suggests the probability of their common origin. Attention has been called to instances of tuberculous infection of the tonsils and adenoid structures, which serve both as receiving reservoirs for bacilli and as points of departure for further dissemination. The reports of various observers as to the frequency of involvement of these tissues have been cited. The faucial tonsils and the lymphoid tissues in the nasopharynx are unusually receptive to wandering bacilli, by virtue of their exposed position and the anatomic peculiarity of their construction. The evidence is apparently conclusive that infection of these parts, even in the absence of pulmonary tuberculosis, occurs considerably oftener than has been supposed, and that a ready transmission may be effected to the ear through the Eustachian tube. Jonathan Wright has repeatedly called attention to the fact that various forms of bacteria are retained upon the surface of the epithelial lining of the tonsillar crypts, while carmin granules and oily particles traverse the tissues without obstruction. He regards the tonsillar crypts as pits especially suited for the lodgment and retention of tubercle bacilli. The cavities are unprotected by cilia, which serve to sweep away the bacteria in upper portions of the respiratory tract. It is evident that the tonsils and contiguous

areas are regions of essential importance as regards the occasional transmission of tuberculous infection to various parts of the body.

The origin of middle-ear tuberculosis is sometimes referable to a distribution of the infective microörganisms through the circulatory channels, but this is, to say the least, quite exceptional, save in cases of general miliary infection. The development of mastoid involvement without middle-ear disease is perhaps suggestive of hematogenous infection. The extension of the tuberculous process to the mastoid *following* middle-ear infection is fairly common, though by no means so frequent as the secondary involvement of the mastoid after *non-tuberculous* otitis media. Personally, I have observed but very few instances of mastoid disease complicating middle-ear tuberculosis among pulmonary invalids. Dr. W. C. Bane reports that not over 3 per cent. of all the cases of mastoiditis operated by him were of tuberculous origin. Dr. J. M. Foster, after a careful review of his cases submitting to mastoid operation during three years, reports no single instance of tuberculous infection. As the result of a wide experience, he is inclined to regard the tubercle bacillus in the production of mastoiditis requiring operation as a negligible quantity. It is hard to subscribe to a statement, recently made, that the common channel of tuberculous infection to the meninges of the brain is by way of the ear.

The onset of otitis media among pulmonary invalids is less often abrupt or attended by acute inflammatory symptoms than among cases of a non-tuberculous nature. An early premonitory symptom is a sensation of slight fulness in one ear, and a beginning impairment of the hearing. At times complaint is made of pain, though this is rarely extreme, and is much less acute than in cases of non-tuberculous otitis media. The pain, though localized in the ear, frequently radiates from this point to the entire side of the head, and there is often present a distinct throbbing sensation. In the beginning there is usually but slight, if any, elevation of temperature, thus differing from the early fever almost invariably present in ordinary acute suppurative inflammations of the middle ear. With increasing distention of the drum, these symptoms, as a rule, become correspondingly more severe, while dizziness and tinnitus aurium are often distressing manifestations. After perforation has taken place a varying amount of purulent secretion is discharged. In addition to tubercle bacilli there is usually present a secondary infection consisting of streptococci, staphylococci, or pneumococci. The pain in most cases disappears with the appearance of the discharge, which, as a rule, is non-odorous, finally becoming scanty and of a thick, tenacious consistency. This often evinces a tendency to dry upon the edges of the perforation, which in some instances is completely covered, producing an underlying maceration of tissue. There is usually a dulling and reddening of the ear-drum as a result of the inflammatory change, and the membrane is thickened to a considerable extent. The perforation varies in size and shape, sometimes an extensive area of the membrane having been destroyed. Necrotic changes in the middle ear occasionally supervene, and the process continues to extend to the destruction of the inner ear, involving the labyrinth, or spreading posteriorly to the mastoid. Fever is common, as is also a *fetid* discharge. The involvement of the mastoid may be either chronic or acute, neither condition, however, being especially frequent in tuberculous disease of the middle ear, though possible of

development as a result of exposure to cold or severe influenza. In this event the pain becomes more pronounced, but is localized more or less in the mastoid region and aggravated by pressure.

As a means of prophylaxis, it is important to caution patients against violent blowing of the nose or practising unconsciously the method of Valsalva, as thereby infected material is likely to be introduced into the Eustachian tubes. Before the stage of pus-formation, the treatment should consist of efforts toward maintaining a free opening of the tube into the middle ear. Catheterization is indicated if cautiously performed. If fever is present, free catheterization, light diet, rest in bed, and the administration of aconite or saline fever mixtures are important, together with the employment of leeches, either in front of the tragus or over the mastoid. Irrigation with hot salt solution is often attended by considerable relief. Paracentesis of the drum is indicated if bulging is prominent. After the perforation has taken place, the chief effort should relate to keeping the ear clean and dry. Routine irrigation is not recommended, but an occasional instillation of a cleansing solution is indicated, followed by careful drying with a pledget of cotton. The latter procedure should be practised by the patient from time to time. General treatment is demanded, as in all other forms of tuberculosis.

Another important source of bacillary infection is found in the **anterior nares.** Although tuberculosis of the nasal cavity is extremely rare, the presence of bacilli in large numbers within the nares is quite common. The investigations of Straus several years ago, as to the existence of bacilli in the nostrils of healthy individuals, attracted wide-spread interest among students of tuberculosis. He demonstrated virulent tubercle bacilli in the nasal cavities in nine out of twenty-nine people, who were brought into association with consumptives. Dr. Walter B. James has reported the experience of Dr. W. Noble Jones, who in 1900 obtained a positive result in 10.3 per cent. of cases from the inoculation of guinea-pigs with the nasal secretions of well people, who were not brought into intimate contact with pulmonary invalids.

Despite the occasional presence of bacilli in the nostrils of healthy persons, and the enormous invasion of the nasopharynx and posterior nares among consumptives by reason of violent acts of coughing, but comparatively few instances of primary tuberculous infection of the nasal mucous membrane have been recorded. Williglk, out of 1600 autopsies, observed only a single case of tubercle deposit upon the nasal septum, although 450 of the subjects exhibited evidences of pulmonary disease (Walsham). Weichselbaum, however, in 146 autopsies upon consumptives, discovered two instances of nasal tuberculosis. In 1900 St. Clair Thomson recorded a case of primary tuberculosis of the nose. Fein has recently reported a probable primary tuberculosis of one turbinate in a trained nurse. Many European observers have cited similar cases, and Heryng collected from the literature a total of 90. In 1906 Onodi reported an extensive primary tuberculous lesion of the nasal septum, although there was no clinical evidence of tuberculous involvement in other parts of the body. It is quite possible a local tubercle deposit might be discovered in more instances were the character of the clinical manifestations such as to suggest detailed inspection. I have seen among pulmonary invalids numerous cases of erosion and

perforation of the septum supervening upon an initial slight excoriation of the mucous membrane, and attended by crust formation, but it is, of course, impossible to assume a tuberculous involvement in such cases. It is apparent that the anatomic structure and physiologic processes within the nose jointly furnish a soil inimical to the growth and development of tubercle bacilli, although these microörganisms are arrested in large numbers with the inspired air. It would seem that the element of protection is referable more to physiologic considerations than to essential peculiarities of anatomic construction. The mucous membrane of the nose is not less permeable than that of the pharynx or larynx, and therefore differences in the susceptibility of the tissues are not attributable solely to changes in the epithelial structures, although the cilia undoubtedly exert a certain protective influence.. The impenetrability of the mucosa by the bacilli is rather to be ascribed to the reflex excitability of the nasal mucous membranes, and to the immediate outflow of defensive secretions upon the inhalation of foreign agents. For a long time the convolutions of the turbinated bones were thought to act as a filter for the bacteria contained within the inspired air. In addition to the action of the vibrissæ at the entrance of the nostril, it is known that an extra amount of viscid fluid is secreted over the surface of the convoluted folds of mucous membrane, when irritated by inhaled dust. The bacteria are kept on the move at least for a considerable distance through the wave-like motion of the ciliated epithelium. They are also washed away from the upper portion of the nose by the gravitating serum, thus affording protection to the region of the cribriform plate of the ethmoid.

It is seen, therefore, that in the complex processes of infection and immunity the cilia act in a mechanic way as agents of defense. According to Wright, von Dungern has demonstrated that the ciliated epithelial cells like the circulating cells in the fluids of the organism, manufacture antibodies, so that it may be inferred that the protection against infection within the nose is not entirely mechanic in nature. Cornet calls attention to the chemic action of the various secretions in inhibiting the development of bacteria, and refers, for illustrative purposes, to the failure to secure pure cultures of pneumococci in this location. It does not seem, however, that too much influence should be ascribed to the supposed chemic processes opposed to bacterial growth in the nose. If such bactericidal properties exist to any considerable extent, infection with the diplococcus meningitidis, and its conveyance through the cribriform plate would be decidedly less frequent than is actually the case. It is probable that the tubercle bacilli are washed from the mucous membrane by the copious secretions, and thus discharged from time to time without opportunity for prolonged retention. It has been shown by Renshaw, Cornet, De Bono, and Frisco that bacilli may gain entrance to the lymphatics through the mucous membrane of the nose in rabbits and guinea-pigs, suggesting at least the absence of bactericidal power in the nasal secretions of animals especially susceptible to general infection. Furthermore, the penetration of the membrane, and the ingress of bacilli into the lymphatic circulation of children, even in the absence of structural change of the mucosa, are suggested by the development of cervical adenitis. Several authors have advanced the possibility of meningeal involvement through the medium of the lymph-spaces emanating from the nose. Irrespective of considerations pertain-

ing to the lymphatics, it is easy to conceive of the probable distribution of the bacilli from the nose and nasopharynx to the immediate region of the Eustachian orifices, with resulting disturbance of the middle ear as the first clinical manifestation of the tuberculous infection.

Further discussion of a subject so purely technical is entirely inappropriate in a book of this character.

Similar considerations preclude more than the briefest possible allusion to the various forms and sites of tuberculous infection of the *eye*. There is no portion of this organ which may not become the seat of tuberculous involvement. Tuberculosis of the choroid was shown by Cohnheim in 1867 to be in most cases a local manifestation of a general miliary infection. It is often associated with meningeal tuberculosis, and occasionally with a similar involvement of the brain. Cornet has referred to the abundant blood-supply of the choroid and attributes to this interesting fact the coincidence of early infection in association with the circulatory distribution of bacilli in miliary tuberculosis. The condition is always bilateral in contradistinction to a unilateral involvement in other parts of the eye, in which the infection occurs as a result of inoculation or secondary extension. Opportunity for direct infection of the eye, and especially the cornea or conjunctiva, would appear more or less abundant among pulmonary invalids on account of contaminated fingers, handkerchiefs, or towels. No instance, however, of such an occurrence has ever come under my observation, but such cases have been reported by others.

The evidences pointing to external infection consist of the unilateral involvement, close association with phthisical invalids if the patient be not the subject of tuberculosis, history of trauma, and absence of preexisting foci of infection in the immediate neighborhood. It is, of course, conceivable that a primary tuberculosis of the cornea or of the conjunctiva may occur from the entrance of infected dust or by the dissemination of bacilli in the act of coughing. The greater frequency of conjunctival tuberculosis as compared with corneal is no doubt explained by the increased facility of retention of microörganisms upon the surface of the former. The removal of foci from these parts is usually followed by complete recovery, without a subsequent return of the tuberculous process. Many instances have been reported of tuberculosis of the iris and occasionally the vitreous, the sclera, retina, and lacrimal sac. Verhoeff, in the early part of 1907, reported some observations in connection with tuberculosis of the sclera. He regards scleritis as almost always a tuberculous process. He observed 13 cases of this condition, in which the diagnosis was made in all instances by the tuberculin test. A general reaction was obtained in all cases and a local reaction in 9. He was unable to obtain evidence of systemic tuberculosis in but 3 cases.

SECTION IX

NON-TUBERCULOUS COMPLICATIONS

CHAPTER LXXIX

MIXED INFECTION

ATTENTION has been called repeatedly to the essential differences observed in the postmortem findings, the symptoms, clinical course, and prognosis of pulmonary tuberculosis. The absence of any conventional type, as shown by the variety of pathologic conditions and the modifications in the character of the disease, is undoubtedly dependent to some extent upon the presence in the tissues of pathogenic bacteria in addition to the tubercle bacillus. While in many instances the clinical manifestations are subject to considerable alteration through the influence of pyogenic microörganisms, the evidence at hand is not sufficient to permit the assumption of a definite and invariable relation of cause and effect. It is known that many bacteria may exist within the elementary tubercle or the surrounding tissues, and be expelled with the tuberculous sputum. They are also found upon mucous or serous membranes, upon walls of pulmonary cavities, in organs of the body aside from the lungs, and sometimes in the blood. These microorganisms may fraternize with the tubercle bacillus, forming a true symbiosis, the more common forms being the streptococcus, the staphylococcus albus and aureus, the pneumococcus, the influenza bacillus, the micrococcus catarrhalis, and the colon bacillus. In addition, several other species, notably the diphtheria bacillus, have been reported by observers. Among my own patients, the above-mentioned microorganisms have been found many times in specimens of washed sputum, and in several instances the pneumococcus and streptococcus in the blood. It is believed that, as a general rule, in the terminal fevers conforming to the septic type, the pus-producing organisms are present in the pulmonary tissues, constituting a bacteremia. The streptococcus has been reported to be present in miliary tubercles before disintegration.

The *relative gravity* of the mixed infection produced by the *various microörganisms* has not been *definitely established*, but in view of the fact that the pneumococcus, staphylococcus, and streptococcus *belong to the well-known group of pathogenic microörganisms*, it is reasonable to *assume a priori* that they are capable of inflicting great damage in the presence of pulmonary lesions. Many times I have noted the presence of the pneumococcus in connection with gross anatomic changes in the pulmonary tissues, as evidenced upon physical examination, but have observed that, as a rule, the general systemic evidences of mixed infection, *i. e.*, chills, mental hebetude, excessive emaciation, and general prostration are more frequent in association with streptococcic or staphylococcic infection. Attempts to attribute the occurrence of pulmonary hemorrhage essentially to the action of the pneumococcus have thus far not been entirely substantiated. Both the staphylococcus

and the streptococcus are capable of producing *severe* constitutional disturbance, the clinical condition being characterized by chills, fever, sweats, rapid loss of weight, physical weakness, and a tendency toward cyanosis, with slight edema of the face and hands. It has rather been my conclusion that the intellect is more likely to be clouded in cases of staphylococcic infection, the mentality often being unaffected if the streptococcus is the offending microörganism. This clinical feature of streptococcic infection among pulmonary invalids is somewhat surprising in view of the well-known delirium attending puerperal septicemia, erysipelas, and other streptococcic infections. The expectoration attending the presence of these pus-producing microörganisms is profuse, heavy, and usually of a greenish-yellow appearance. Though usually distinctly purulent and raised with ease, it is sometimes decidedly ropy and tenacious.

The influence of the influenza bacillus is somewhat doubtful as far as the destruction of tissue is concerned, although areas of bronchopneumonic consolidation frequently result. As a rule, these pneumonic processes are not of long duration, resolution taking place in from several days to a few weeks. In exceptional cases, however, I have observed a persistence of the consolidation until after the lapse of several months, when the physical evidences of the condition finally disappeared. A notable instance of this condition is reported in connection with Differential Diagnosis. A pronounced influenza infection is often accompanied by increase of fever, malaise, aching of limbs, impaired appetite, and aggravation of cough, the latter being more or less paroxysmal in nature in some cases.

I have found the colon bacillus very largely responsible for the clinical symptoms attending infection of the genito-urinary tract, and have observed remarkable improvement following the exhibition of a colon bacillus vaccine derived from the urine. Hematuria and associated symptoms suggestive of tuberculosis of the kidneys and of other portions of the genito-urinary system have entirely disappeared under treatment for the mixed infection. The reader is referred to Case No. 22 upon p. 752. The nephritic disturbances so common in cases of advanced pulmonary tuberculosis undoubtedly are produced in many instances as a result of the multiple mixed infections persisting during indefinite periods.

The clinical evidence is amply sufficient to substantiate the belief that a prolonged secondary infection, though slight in degree, is sufficient to produce desquamative and degenerative changes in the kidneys of pulmonary invalids. Several times I have noted the development of severe acute nephritis following a temporary streptococcic infection of the tonsils. The clinical symptoms in these cases were of so urgent a nature as to suggest the probability of a general septicemia. Chronic parenchymatous nephritis has frequently followed other secondary infections if long continued, even though apparently of slight severity. A large number of patients have developed well-defined nephritic disturbances, after apparent arrest of the tuberculous process, suggesting a possible relation between the gradual onset of kidney irritation and the acquired immunity from the tuberculous disease. It has almost seemed in some cases that the price paid for the subsidence of the activity of the tuberculous infection is the insidious development of nephritis. Irrespective, however, of this feature as applied to pul-

monary invalids in general, it is demonstrated that kidney disturbances are much more common in those cases of pulmonary tuberculosis exhibiting varying degrees of secondary infection. Many cases are almost devoid of clinical symptoms, while others exhibit either vague or indefinite manifestations. A considerable number, however, present symptoms undoubtedly due to insufficiency of the kidneys, although often attributed to the effects of pulmonary tuberculosis. Among these are included slight edema, rapid pulse, varying degrees of dyspnea, gastro-intestinal disturbance, cyanosis, and mild chronic uremic symptoms. The more common evidences suggestive of nephritic involvement are fatigue and rapid pulse. These are often present upon slight exertion in the absence of all other clinical manifestations referable to the kidney condition. Dyspnea is frequently *out of all proportion* to the amount of *respiratory incapacity* occasioned by the *pulmonary involvement.* Edema of the face, hands, feet, and ankles is also common, as is diarrhea, though the latter is more frequently associated with amyloid degeneration. I have been unable, from my own observations, to ascribe as much significance to pain and aching in the lower back as have other observers. The pulse-rate, while abnormally rapid in many cases, is not invariably accompanied by an increase of arterial tension. Upon the contrary, it has been my experience that the blood-pressure is frequently under 100 in cases of nephritic involvement in the course of pulmonary tuberculosis. Cardiac murmurs have not been found unduly frequent or possessed of special significance in these cases.

The examination of the urine often fails to disclose the presence of large numbers. The albumin, though usually found in amyloid or albumin, although hyaline and granular casts may be present in very advanced parenchymatous change, is, nevertheless, absent in a surprising number of cases in which the casts show long-continued irritative and degenerative change. It is known that among non-tuberculous individuals, hyaline and fine granular casts are present in numerous cases, particularly during middle life or later years, without the slightest trace of albumin. They are also observed in lithemic patients, whose physical exercise has been of necessity greatly restricted as a result of the tuberculous disease. These individuals exhibit gastro-intestinal disturbances, joint manifestations, and other evidences of impaired metabolism. It is not to be supposed that the development of kidney changes among pulmonary invalids in health resorts may be referred to the influence of high altitude, as some would have us believe. Not infrequently have I observed the nephritic disturbance to improve materially, and even to disappear altogether upon change of residence to lower elevations. It is none the less true, however, that instances of similar improvement are witnessed in *spite* of *continued sojourn in high altitudes* and even upon change from sea-level to the elevated regions of Colorado. Clinical evidence is assuredly sufficient to refute statements that residence in high altitudes tends to provoke kidney irritation.

It is probable that the toxemia responsible for the development of nephritis is produced, to some extent, by the microörganisms of mixed infection, as well as by the irritating products of imperfect metabolism. The precise pathologic *effect* of these microörganisms upon the *subsequent course* of pulmonary phthisis is not yet fully determined. That a distinct modifying influence is produced by the bacteria of secondary infection is, however, beyond question. It is well established that the

accompanying bacteria play an important rôle in the development of the *pathologic* processes common to pulmonary tuberculosis, and serve to characterize *clinically* certain phases of the disease, but a clear and accepted differentiation of the entire part assumed by the several microörganisms in the pathogenesis of consumption has not thus far been made.

Some features of mixed infection remain the subject of material differences of opinion among trained observers. Many clinicians regard all pronounced temperature elevations as referable directly to the action of secondary microörganisms, while others maintain that the tubercle bacillus alone is responsible for the fever of pulmonary tuberculosis. A rational interpretation of the relation of mixed infection to the fever of phthisis points at least to an appreciable influence, in cases of the hectic type, for chills, sweats, and prostration, definitely characterize bacterial infection of other organs of the body. Upon the other hand, manifestations of a like character may apparently be produced by the presence of the tubercle bacillus alone. That absorption of the toxins of the bacillus may give rise to the exhibition of symptoms, simulating the septicemia of mixed infection, is suggested by the frequent results following an administration of the various preparations of tuberculin. It thus follows that the so-called clinical picture of mixed infection is *not always produced solely by secondary microörganisms*, but that it may result from the action of the *tubercle bacillus alone* or in *combination* with other agents of bacterial infection. The clinical manifestations of pure tuberculous origin are not essentially different from those dependent upon mixed infection, the chilly sensations, aching of limbs, sweating, general prostration, and other constitutional disturbances being subject to considerable variation. It is probable, however, that in the majority of cases the so-called hectic fever of phthisis is associated with a definite secondary infection.

It is generally believed that a disproportionate effect upon the circulatory apparatus, reflexes, and mental attitude is peculiarly suggestive of the action of the tubercle bacilli, while excessive emaciation and exhaustion, violent cough, copious expectoration in addition to high fever, indicate a probable secondary infection. This relation, though commonly observed, does not invariably obtain. Changes in the mental condition and in the character of the circulation are by no means a constant accompaniment of pure tuberculous infection, and often are exhibited in association with other bacterial infections, even without excessive temperature elevation. I have repeatedly observed among consumptives extreme mental hebetude and slowness of pulse, without fever, in connection with the microörganisms of mixed infection. In other instances of secondary infection there may be noted either excitability of temperament with acceleration of pulse, or depression of spirits and melancholia. It has been rather my experience that dulling of the intellect, as mentioned, is particularly likely to occur in cases of infection with the staphylococcus aureus.

Rapid emaciation, violent cough, and profuse expectoration, though more likely to attend instances of severe mixed infection, nevertheless may exist in the absence of such a condition. While it is true that the breaking down of tuberculous tissue is facilitated by the presence of the pus-producing organisms, yet the process of softening and excavation may take place regardless of the streptococcus or staphylococcus.

These latter pathogenic microörganisms unquestionably aid in the disintegration of the tubercles, and thus in the exodus of the parasite, but it is not clear that they stimulate the growth of the tubercle bacilli. Upon the contrary, despite the frequent urgency of symptoms and the progressive decline of the invalid, evidence is not lacking to support the theory that multiplication of the bacilli is sometimes repressed by the bacteria of secondary infection, much as the tubercle bacilli are annihilated and overcome by other bacteria outside the body. Several times recently I have noted a complete disappearance of the tubercle bacilli from the sputum in cases of severe mixed infection.

The presence of secondary microörganisms in the sputum affords no reliable measure of the severity of the mixed infection. In fact, nearly all the bacteria said to be responsible for the clinical manifestations of secondary infection may be found in the throats and mouths of apparently healthy people. The discovery of their existence in the sputum is, therefore, robbed of a portion of its special significance unless precautions are taken to avoid contamination of the sputum with infection from the throat and mouth. For this purpose a sterile, cleansing mouth-wash consisting of a saturated solution of boric acid may be used before the sputum is expectorated. This is washed with sterile water and a portion selected for examination from the center of the mass. Even after the careful execution of these preliminary precautions, the bacterial findings are not always conclusive as regards the clinical severity of the infection. The various bacteria of secondary infection may often be found in profusion in washed sputum in the absence of the slightest clinical suggestion of their presence in the tissues.

A study of the mixed infection of pulmonary phthisis in connection with the employment of bacterial vaccines during the past year has demonstrated the surprising frequency of streptococcic, staphylococcic, pneumococcic, and influenza infection, as shown by the bacteriologic examination of the sputum, in the absence of temperature elevation or of other constitutional symptoms commonly associated with such conditions. It also has been of some interest to note, as intimated previously, that, in the majority of cases of mixed infection, particularly if accompanied by well-defined clinical symptoms, the tubercle bacilli have been considerably less numerous than in instances of seemingly pure tuberculous involvement. Upon the other hand, the characteristic constitutional evidences of secondary infection are often observed in *spite* of *failure to discover the specific microörganism* in the sputum. Inability to recognize the agents of infection by a single bacteriologic examination should not be construed, however, as negative evidence. It is frequently possible to demonstrate the bacterial nature of the infection in doubtful cases only after very many examinations, both microscopic and cultural. In a considerable number of cases, however, continued efforts toward the detection of the microörganisms remain utterly futile, even in association with a perfect clinical picture of severe secondary infection. Thus it is clear that clinical manifestations suggesting the existence of this condition may be exhibited in some cases of purely tuberculous origin, an assumption apparently confirmed by clinical experience and bacteriologic investigation.

The recognition of mixed infection, therefore, is attained at times with much difficulty, its differentiation from miliary tuberculosis in

particular often being obscure and imperfect. During a comparatively short period of time the symptoms of the two conditions may appear practically identical. The recognition of the microörganisms in the sputum is not of itself sufficient to establish definitely the diagnosis of a mixed infection as the sole responsible cause for the clinical manifestations. As already stated, these microörganisms are sometimes found in profusion despite careful technic without the advent of any clinical symptoms, and, further, the agents of bacterial infection in the sputum may coëxist with the development of miliary tuberculosis. It is not always permissible in these cases to reach a positive diagnosis of miliary tuberculosis merely upon the exclusion of secondary infection as the result of negative bacteriologic examinations. Upon the whole, the diagnosis of this condition must be determined upon the basis of the principles previously enumerated in connection with miliary tuberculosis, involving a systematic physical examination and a well-considered analysis of all available clinical data. For general purposes, it is reasonably safe to assume provisionally that the condition is one of mixed infection, and to recognize only the remote possibility of a miliary involvement, provided the clinical manifestations suggestive of the former are reinforced by recognition of the microörganisms in the sputum. It is claimed that repeated observations of the opsonic index may sometimes suffice to establish a definite diagnosis in cases previously admitting of reasonable doubt. In the enthusiasm attending recent laboratory aids to diagnosis care should be exercised not to overlook important clinical features. The fever of miliary tuberculosis is not subject to the same degree of fluctuation as that of mixed infection, is less often associated with chills, but is attended more frequently by headache, dyspnea, and mental symptoms. With the early development of motor disturbances, discoverable upon careful examination, all possibility of error is removed.

Prognosis of Mixed Infections.—The prognosis of all mixed infections characterized by clinical symptoms is primarily identical with the prognostic significance attaching to fever, which has been described. The outlook for the patient must be adjudged largely in accordance with the principles outlined in connection with a persisting fever. The prognosis is grave not merely from the presence of fever, but from its continuance. Many cases with long-continued mixed infection of great severity sometimes respond to appropriate treatment. The prime obligation of the medical attendant relates, as far as possible, to remedial rather than palliative measures. No practice can be more superficial than the effort to lower temperature temporarily through medicinal or hydrotherapeutic agencies, without immediate recourse to the employment of other means tending to prevent its recurrence. Night-sweats, diarrhea, cough, and even hemorrhages may be treated as they arise, through methods found to be productive of temporary relief, but the fever of sepsis demands far more than the employment of measures to increase the comfort of the patient. If the policy of *laissez faire* is instituted, the future contains nothing for the patient but speedy disaster. If active steps are taken to combat the sepsis of mixed infection, the condition of the invalid is in no wise made worse, even in the event of failure, and in many cases the results obtained are most gratifying. The measures which I have been in the habit of employing for many years are—(1) The most complete interpretation of the rest treatment;

(2) the use of the antistreptococcic serum (now seldom used); (3) during the past year the administration of the bacterial vaccines derived from the sputum of the patient, as suggested by Wright.

Management.—The preliminary essential factor in the control of fever is *rest*. Its effect is often remarkable, provided the invalid is kept in bed at all times. Coincident with the reduction of temperature there is a corresponding improvement of appetite, digestion, and assimilation, with resulting increased nutrition and greater powers of resistance. In some cases the diminution of fever is immediate upon the adoption of the recumbent position. There are many patients, however, who exhibit at first but slight subsidence of temperature elevation, months sometimes elapsing before the fever recedes to the neighborhood of 100° F. While the prolonged indefinite period of rest constitutes a trial to one's patience and courage, the invalid is constantly laying the foundation for a possible ultimate and complete recession to normal. Any special deviation from the strict interpretation of the principles of the rest treatment, even for a short time, is inevitably destined to result in failure. This method should be adopted as a *preliminary* measure in *all cases* presenting the septic fever of advanced tuberculosis, save in the presence of such special indications as demand prompt recourse to more radical procedures. Whenever, from the antecedent history, it is apparent that the continuance of the rest treatment offers no reasonable assurance of success, refusal to resort to specific medication, even if believed of doubtful utility, represents, nevertheless, culpable negligence on the part of the physician.

In a *few* cases conspicuously gratifying results have been obtained by the administration of the antistreptococcic serum. In former years a justification for the employment of this agent, concerning which comparatively little was known and the clinical effects of which were not invariably favorable, was found in the unfortunate prognostic import of continued high fever. While the rationale of its administration has been incapable of bacteriologic demonstration, practical results, far beyond the limits of laboratory knowledge, were sometimes obtained. No medical growth can take place without recourse to investigation and experiment. Development should take place along clinical lines, as well as from the results of laboratory research. It is known that in streptococcic infections the toxins are not soluble in the blood, but are inclosed within the microörganism itself, constituting an endotoxin, hence a neutralization of the toxins, as in tetanus or diphtheria, is impossible. It has been shown by Bordet, von Lingelsheim, and Denys that in animals, following the administration of an antistreptococcic serum, a previously existing negative chemotaxis is converted into a positive one. As the repellant action between the microörganism and the leukocytes is changed into an attraction, there is afforded added opportunity for resulting destruction of the streptococci by the inglobing and digesting of the microörganisms. Thus far the results obtained in animal experimentation have not been found to hold true in man. This fact, however, should not be construed as being sufficient to preclude altogether the administration of the serum, for the clinical evidence of its value in a small number of cases appears incontrovertible.

The results of my observation attending the use of the *antistreptococcic serum* were reported five years ago. A considerable experience since then has emphasized my conviction as to its utility in desperate

cases, failing to exhibit improvement through other means. While thoroughly cognizant of some of the disadvantages attending its employment, I have seen thus far no valid reason to discountenance its tentative administration in *properly selected cases*. The particular type of cases in which there has been afforded a justification for the use of the serum must be understood to be that class exhibiting well-defined clinical evidence of streptococcic infection, substantiated by the presence of the microörganisms in the sputum or blood, and associated with such constitutional disturbances as chills, irregular elevations of temperature, sweats, and general prostration. Any physician having considerable experience in the management of tuberculosis, and constantly brought into intimate association with the disease, cannot fail to be impressed with the great significance of a pronounced streptococcic infection. There is ever impressed upon the medical attendant an appreciation of the *disproportion* frequently existing between the *physical signs* and the *general condition* of the patient. Many with comparatively slight activity of the tuberculous process, and with small areas of pulmonary involvement, in the presence of this infection have been forced to an irresistible decline. My conclusions, previously reported, are briefly summarized as follows:

1. About one case out of every four or five may reasonably be expected to exhibit an appreciable diminution of temperature by the end of a week or ten days.

2. The remaining cases do not show any bad results from its employment, other than the occasional intolerance of the system for the serum of the horse.

3. This so-called reaction, which is independent of the specific nature of the remedy, but common to all other serum preparations, bears no relation to the ultimate results obtained.

4. Some cases show marked improvement in spite of temporary discomfort in the way of chills, fever, urticaria, and painful swelling, with stiffness of the joints, while others exhibit no improvement, although there is entire absence of constitutional disturbance.

5. Reaction may take place within twelve hours after the use of the serum, or it may be delayed for six weeks.

6. Occasionally the improvement is indefinitely delayed until the occurrence of the reaction, following which there may be complete and enduring subsidence of the fever.

7. As a result of the serum, the temperature may either subside to normal, or be reduced several degrees, remaining, however, somewhat elevated.

8. I have not been in favor of its continued subcutaneous employment, and have given, as a rule, not over four or five doses at intervals of one or two days.

9. I have occasionally practised the tentative administration of the remedy by the rectum for ten or twelve doses before resorting to its hypodermatic use, in order to avoid the discomfort which sometimes follows its injection into the tissues, but have been unable to secure satisfying results from this method.

10. I have seen unquestionable good attend its use even when streptococci were not found in the sputum, and believe that under such conditions the clinical evidences of a persisting sepsis may *sometimes* afford, from a humanitarian standpoint, a warrantable basis for its use.

Bacterial Vaccines.—The foregoing considerations pertaining to the use of the antistreptococcic serum are introduced in justification of its employment by physicians, who are unable to avail themselves of the recent advantages offered by the use of the bacterial vaccines, to which detailed reference will be made in a later chapter. The scope of their application, particularly in connection with the opsonic index, is of necessity greatly limited among general practitioners by the absence of laboratory equipment and training. Under such circumstances recourse to the antistreptococcic serum in cases of severe streptococcic infection is not only justified, but in some cases demanded.

The principles upon which depend the elaboration of an artificial resistance to infection will be discussed under the subject of Immunity. Through the genius and indomitable labor of Sir A. E. Wright, certain valuable contributions have been made to the elucidation of the complex mechanism of immunity. The chief of these discoveries related to an unsuspected substance in the blood, to which he gave the term "opsonin," and which was found to act on the bacteria. It is the function of this element to prepare the bacteria for inglobing by the leukocytes. Wright found that these opsonins could be increased in the blood by the introduction of cultures of dead bacteria. Bacteria suitably prepared for injection were called by him "vaccines." A description of the preparation of vaccines occurs in connection with the Theories of Immunity. His elaborate technic for the precise determination of the opsonic power, with reference to the various forms of bacterial invasion, will be reviewed in detail, together with the status of our present knowledge regarding the principles of opsonic therapy. The practical application of vaccine therapy to cases of secondary infection accompanying pulmonary tuberculosis I have made the subject of considerable clinical study. My observations have been actuated largely by reason of the *frequent unreliability* of the *antistreptococcic serum* and its other obvious *disadvantages.* An effort was also made to ascertain, if possible, the results to be obtained from the employment of tuberculin medication, in cases of pulmonary tuberculosis uncomplicated by mixed infection. In view of the fact that the scope of my investigation embraced cases of pure tuberculous involvement as well as of secondary infection, further discussion of the subject will be reserved for the consideration of Specific Medication in Pulmonary Tuberculosis.

CHAPTER LXXX

PREGNANCY

Pregnancy as a complication of pulmonary tuberculosis is almost universally believed to be distinctly detrimental to the health of the consumptive, regardless of the extent or activity of the disease. Some observers assert that the harmful effects may be expected to develop shortly after conception has taken place, and continue without interruption until the termination of labor or convalescence from the puerperal period. The majority of clinicians, however, incline to the belief that

the unfavorable influence of pregnancy upon the course of pulmonary phthisis is exerted chiefly after childbirth. Nearly all agree that the combined effect of pregnancy, the puerperium, and lactation constitute a tremendous tax upon the physical energies of the consumptive, and directly lower the powers of resistance. In view of the clinical observation as to the frequent increased activity of the tuberculous process after childbirth, with a progressive subsequent decline, pregnancy has come to be generally regarded as a factor of grave prognostic import among such patients.

Instances of actual improvement in the condition of the tuberculous lungs as a result of concurring pregnancy rarely have been recorded. It is but natural, therefore, that pulmonary invalids should have been instructed as to the inadvisability of marriage, the imperative avoidance of conception, and even the expediency of a speedy termination of pregnancy. It is true that a complete justification for such advice often obtains in special instances, when efforts toward the preservation of the tuberculous mother properly become the paramount consideration. It is not *invariably* the case, however, that such precipitate action is warranted.

The existence of pregnancy *per se*, *irrespective* of important features inherent to the *individual* case, is not to be regarded as necessarily inimical to the welfare of the consumptive, nor as *prima facie* justification for the performance of abortion. Its development among pulmonary invalids as a class is assuredly to be deplored, and unfortunate results must of necessity be expected in a large number of cases, if the pregnancy is permitted to continue to full term. It is to be remembered, however, that generalizing statements concerning the influence of pregnancy upon consumption are not always correct in their individual application. As a matter of fact, each case is worthy of thoughtful, well-considered action based upon the merits of its several features.

The conditions obtaining in special cases may suggest the advisability of prolonged, detailed observation, and in others demand recourse to prompt and energetic measures in the way of surgical relief. Unfortunately, the great majority of cases are adjudged in accordance with hastily formed opinions, or even preconceived notions as to routine principles of procedure. The practical lessons taught by a considerable experience among such a class of invalids are somewhat surprising in the light of generally accepted views. No denial can be made of the deleterious effect of pregnancy upon a vast number of pulmonary invalids, but such influence is by no means invariable. It is not always clear that the rapid progress of the tuberculous affection after childbirth is distinctly referable to the pregnancy or the puerperal period.

It is well known that conception may take place at almost any time during the course of pulmonary tuberculosis, even in far-advanced stages of the disease. Among so desperate a class, a rapid progressive deterioration of the physical condition, with a fatal termination, may be reasonably expected by the end of one year, *with* or *without* the added influence of pregnancy. It is thoroughly substantiated that the effect of pregnancy upon the general health, and the course of the pulmonary involvement *may* be decidedly favorable in a few instances. I have observed several patients who presented, during the entire period of pregnancy, and particularly in the earlier months, remarkable evidences of general and pulmonary improvement. This

was often illustrated by increase of weight and strength, diminution of cough and expectoration, and reduction of the temperature. The nausea and vomiting commonly incident to early pregnancy are often singularly lacking among consumptives, thus precluding a diminution in the ingestion of food and the consequent loss of nutrition. On the contrary, the appetite is sometimes enhanced materially, and the digestion unimpaired or improved, with resulting gain in weight. It is certainly true that physiologic processes, previously dormant, are often stimulated to such a degree as to produce a change in the general nutrition of the utmost benefit. I have been privileged to observe in a few cases during pregnancy, even the complete disappearance of *all* the subjective and physical evidences of pulmonary tuberculosis, which previously had been persistent for several years. I have in mind two conspicuous instances of advanced tuberculous infection of several years' duration, for whom the development of pregnancy proved of undoubted benefit. In each case the pulmonary process became entirely arrested during pregnancy, and was not followed by a renewed activity of the infection after the termination of labor. For the sake of exactitude the two cases are briefly reported as follows:

Case 1.—A woman, twenty-six years old, consulted me in March, 1901, two and one-half years after arrival in Colorado, and five years after the development of pulmonary tuberculosis. There had taken place a loss of twenty-five pounds in weight. The cough and expectoration were moderate, and the general condition good. There was extensive involvement of the left lung, moist râles being readily detected upon easy respiration from apex to base, both front and back, with considerable consolidation in the upper portion. In the right side there was slight infiltration with moist râles at the apex. Bacilli were numerous. During the first two years that she remained under my observation, in spite of a material gain in weight, there developed unmistakable evidences of an increased activity of the tuberculous process. The cough and expectoration perceptibly increased, dyspnea became much more pronounced, the pulse accelerated, and beginning physical evidences of cavity formation were recognized in the left upper front. She then became pregnant, and shortly afterward suffered to an unusual degree from nausea and vomiting, until, at the end of two months, she reluctantly consented to the evacuation of the uterus. This procedure had been advised from the beginning upon the score of the extensive active tuberculous involvement, and the interference with proper nutrition. The patient recovered rapidly from the effects of the curetment performed by Dr. W. S. Bagot. At the end of two years she again became pregnant and prompt interference was advised. There had developed a large cavity in the left upper lobe below the clavicle, and moist râles were recognized throughout the left lung, and in the right apex to the third rib. There was a loss of ten or fifteen pounds in weight from the normal, paroxysmal cough, copious expectoration, slight temperature elevation, and moderate dyspnea. All efforts to influence the patient to consent to the termination of the pregnancy were unavailing, nausea and vomiting being comparatively insignificant. After the second month there ensued a diminution of cough and expectoration, and the beginning of a remarkable gain in weight, which continued for months after childbirth. With improvement in the general condition, there took place a diminution in the

activity of the tuberculous infection, as shown by the lessened amount of moisture upon examination. At the expiration of her period of pregnancy she had attained a very material gain in weight, and there was an entire disappearance of cough and expectoration. Fine clicks at each apex were barely recognized at the end of inspiration following a cough. Labor was exceedingly difficult and exhausting, the presentation being a breech, and the progress necessarily slow in spite of strong uterine contractions. The patient was not allowed to nurse the child, nor to share to any extent in the responsibilities involved in the care of the infant. The remarkable improvement, noted for the first time during the *course* of the pregnancy, was continued without interruption during the following year. The patient was permitted to return home in 1906, exhibiting at that time, upon examination, no evidence of any existing active tuberculous involvement. There was entire absence of moisture in the finer bronchi, as well as of cough and expectoration. She displayed a gain of fully fifty pounds in weight, and thus far has suffered no relapse. Upon the basis of the clinical evidence, it is reasonable to assume that the pregnancy constituted an important factor in restoring the patient to a life of usefulness and comparative health.

Case 2.—A woman, aged twenty-two years, consulted me immediately upon arrival in Colorado in February, 1903, three years after the development of pulmonary tuberculosis. There was a loss of thirty pounds in weight and an excessive cough. The expectoration amounted to eight ounces in twenty-four hours and contained numerous bacilli. There were daily temperature elevations of two or three degrees and marked dyspnea. Examination disclosed extensive active tuberculous involvement of the left lung, with areas of consolidation, and moist râles from apex to base, front and back. A beginning tuberculous infection of the right apex was noted. During the following eighteen months there was presented a progressive improvement in all respects. A gain of forty-five pounds in weight was established, with corresponding improvement in the pulmonary condition. She then moved to another city in Colorado, and did not come under my observation again until late in 1905, when she was found to have lost nearly twenty pounds in weight, and was experiencing a decided increase of the cough and expectoration. Upon examination moist râles were readily detected from apex to base upon the left side. Efforts to increase nutrition and promote the general condition were unavailing until she became pregnant in the late spring of 1906. Thereupon there developed a remarkable improvement in appetite and digestion. This was the precursor of a pronounced gain in weight, with an eventual disappearance of the cough and expectoration. She was examined in the early fall, and for the first time since coming to Colorado, exhibited an entire absence of physical signs. The gain thus established during, and presumably as a result of, the pregnancy has been maintained to the present time.

Several other cases have been observed which illustrate the coincidence of an undoubted improvement in the general condition and in the physical signs during the period of pregnancy. In these cases the clinical data strongly suggested a relation of cause and effect. A fever previously persistent has been found, in exceptional instances, to disappear with the development of pregnancy. It is but fair to state that the improvement was usually quite unexpected, in some cases,

premature delivery having been recommended and refused. It is apparent that pregnancy is not always distinctly detrimental to the interests of the consumptive, that *some* patients may secure a temporary gain during the period of gestation, and that a *few* may derive permanent benefit through its influence.

In addition to the extent, nature, and degree of activity of the tuberculous lesions, the amount of fever and loss of weight are vitally important considerations in the determination of a rational course of procedure. An essential feature is the recognition, during the first few months of pregnancy, of any appreciable change in the cough, expectoration, nutrition, temperature elevation, and physical signs. The present *nutrition* of the invalid, together with the number and history of previous pregnancies, must be regarded of great importance in estimating the probable influence to be exerted during succeeding child-bearing periods. In general it may be assumed that greatly impaired nutrition is in itself a distinct contraindication to the continuance of pregnancy. It has been asserted by some clinicians that *repeated* gestations are uniformly productive of unfortunate results. I have not found this to be invariably true. Several patients have been observed, who have apparently undergone the second and third accouchement quite as well as the first. The following case is of some interest:

A woman, thirty-three years of age, after three years' residence in Colorado, came under my observation in December, 1896, five years after the onset of a tuberculous infection. She was at that time four and one-half months pregnant, and had already borne six children, all living and in good health. She had done her own housework in addition to caring for the children. There was a loss of nearly twenty pounds in weight, slight cough and expectoration, and well-defined physical evidences of tuberculous lesions at each apex. The confinement was normal and followed by no appreciable tendency toward further decline. The patient eventually secured a complete and permanent arrest of the tuberculous process, with disappearance of cough, expectoration, and physical signs of active infection.

It is a matter of common clinical observation that some patients, in spite of improvement during the period of pregnancy, exhibit a rapid decline following parturition. Just why this phenomenon should take place is somewhat difficult of satisfactory explanation. It cannot be that such results are referable to the mere process of labor, with its attending pain and exhaustion, for an unfavorable influence is not infrequently exerted even after a brief and easy parturition. It is also questionable if the mere emptying of the uterus produces so complete a change in the physiologic processes as to bring about a renewed activity of the tuberculous lesions. It is quite probable that, to some extent, the unfortunate clinical results are referable to the burdens of motherhood, the frequent lactation, the confinement to the house, and the added responsibilities incident to the care of the child.

But slight, if any, unfavorable effect of the labor may be anticipated in most cases, if the confinement is terminated as quickly as possible under the judicious employment of anesthesia. This should be followed by immediate bandaging of the breasts and the avoidance of lactation, the placing of the invalid upon vigorous supporting treatment, and adherence to a rational system of living.

It sometimes happens that a *premature* termination of labor is attended by distinctly unfavorable results, often in excess of those exhibited after normal parturition. Patients presenting definite evidences of improvement during the earlier months of pregnancy, have been observed to undergo a pronounced decline following an accidental miscarriage. This is referable in part to excessive loss of blood and the resulting exhaustion, but a general decline sometimes follows the evacuation of the uterus by artificial means. This is much less likely to take place, however, following prompt and thorough curetment during anesthesia, than after tedious and painful methods of producing abortion. The *insertion of catheters, bougies, and sounds*, though sometimes thought to be indicated in cases of *advanced phthisis* on account of objections to the administration of an anesthetic, is, upon the whole, worthy of condemnation. As stated in connection with the discussion of surgical operations upon pulmonary invalids, the dangers and disadvantages of anesthesia to such patients are greatly overestimated. A painless and speedy evacuation of the uterus is seldom, if ever, attended by unpleasant results, while prolonged efforts to expel the fetus by means of uterine contractions, excited through the presence of a foreign body, are often productive of serious hemorrhage and profound physical exhaustion. It is chiefly in the latter class of cases that consumptives are observed to do badly following miscarriage. I recall the case of a young woman of twenty-three, who came to Colorado in 1903, three months pregnant, presenting the history of a tuberculous infection immediately following a miscarriage two years previously. There were excessive cough and copious expectoration, moderate loss of weight, slight temperature elevation, with active tuberculous infection of the left lung from apex to base, front and back. Throughout this region there were signs of slight consolidation, with moist râles upon easy breathing. The patient exhibited a pronounced improvement during the first month in Colorado, there taking place a diminution of cough and expectoration and a materially improved nutrition. Upon induction of premature labor by the insertion of a catheter in the hands of a surgical colleague, the uterus was finally emptied after the lapse of thirty-six hours. This was followed by an immediate exacerbation of fever and other unfavorable symptoms, representing the beginning of a relentless decline, which was terminated by her death a few months subsequently. In this instance the influence of the pregnancy itself had not been harmful, but the induction of premature labor marked the onset of a renewed activity of the tuberculous process.

It is clear that no general rule may be formulated relative to the effect of pregnancy upon pulmonary tuberculosis which can properly be applicable to all cases.

The preceding course of remark is not to be construed in advocacy of an invariable continuation of pregnancy, but more as an emphasis to the fact that the effect of this condition is not always detrimental, and that unfortunate results often attend precipitate interference.

CHAPTER LXXXI

SYPHILIS

The coëxistence of syphilis and tuberculosis is much more frequent than generally supposed, but the precise relation of the two infections to each other remains somewhat doubtful. The dual association of these diseases, which represent the two most frequent and dreaded scourges to which mankind is subject, is of special interest to the clinician by virtue of the **influence exerted by one infection upon the other,** and the **possibilities of error in the differential diagnosis** of the thoracic manifestations.

The common relation of syphilis to tuberculosis consists of—(1) the influence of syphilis upon the vulnerability of the tissues to *future* tuberculous infection; (2) the effect of syphilis upon the course of a *previously acquired* tuberculosis; (3) the modifying action of *tuberculosis* upon *syphilitic* infections of remote and recent origin.

Various widely conflicting views have been expressed by observers as to the clinical results exhibited by the combination of the two diseases. The somewhat singular divergence of opinion is perhaps explainable by the failure of clinicians to recognize the same essential differences of classification. Thus the extent and character of the influence exerted by one infection upon the other are dependent to a great degree upon their *relative development* in point of *time.* It goes without saying, moreover, that marked differences exist in the virulence of each infection. Observation of a large number of patients afflicted with both diseases will necessarily include some presenting clinical evidences of an intensely virulent syphilis, with comparatively insignificant tuberculosis, and others exhibiting an apparently benign syphilitic infection, with active advancing tuberculous processes. A progressive destructive tendency of both infections will sometimes be noted, while among other individuals the clinical manifestations incident to both diseases are subject to ready control.

Another important consideration is the personal equation, which involves the question of alcoholism or other excesses, vigor of constitution, mode of life, occupation, financial status, and temperamental peculiarities, all vastly influencing the amenability to treatment. While an arbitrary classification of cases, therefore, is not permissible, certain broad generalizations are in order, as evidenced by the results of clinical observation.

Hereditary syphilis is known to predispose toward the development of tuberculosis. It is natural to suppose that the puny, ill-nourished children of syphilitic parents should exhibit, as a result of their impaired vitality, a pronounced diminution of resistance to tuberculous infection. It has been shown that, as regards tuberculosis, the influence of heredity consists in most cases of the transmission to the infant of an enfeebled constitution, with impaired powers of resistance to tuberculous infection. In hereditary syphilis, however, a direct specific taint is inflicted upon the child, but the enfeeblement of constitution is no less apparent than in children born of tuberculous parents. It may well be imagined that the physical debility, retardation of growth, and imperfect development exhibited as a result of infantile syphilis are accompanied by a corres-

ponding weakening of tissue resistance. Clinical observation suggests that, in addition to these incontestable factors, a direct predisposing influence to tuberculosis is exerted by the inherited syphilitic taint, regardless of nutrition or apparent vigor of constitution.

It cannot be truly said that tuberculosis attacks only those syphilitic children who present suggestive manifestations of an inherited taint. I have frequently noted that seemingly healthy children, whose parents have been admittedly syphilitic, after thriving for one or two years, suddenly fall victims to tuberculous infection. The suggestion derived from such an experience, as to the ultimate predisposing influence of the syphilitic virus in young children, is of some interest in comparison with the *surprisingly few* instances of tuberculosis, observed among children, one or both of whose parents were tuberculous at the time of conception. During many years of observation in a health resort for pulmonary invalids, comment has been made repeatedly upon the comparatively few cases of tuberculosis in childhood, despite the existence of active infection in the parents and of exceptional opportunities for acquired infection through almost wanton exposure. Upon the other hand, instances of tuberculous development in children have not been infrequent when a history of syphilis has been freely admitted by a parent, or its previous existence strongly suspected. For the foregoing reasons it may be accepted in general that the transmission of hereditary syphilis to young children greatly increases the vulnerability of the tissues to tuberculous infection.

It is also probable that among young adults, the depressing influence of acquired syphilis increases to some extent the susceptibility to tuberculosis. Instances of active tuberculous infection, following closely upon the contraction of syphilis, are not uncommon. There is borne in mind the case of a young man who recently consulted me presenting a history of pulmonary tuberculosis which developed not over two or three months after the appearance of the initial lesion. I have observed several cases in which the malnutrition incident to recent syphilis *has appeared* to favor predisposition to tuberculosis. In such cases, if the tendency to tuberculosis is not directly augmented by the syphilitic taint, it is at least clear that, through diminished resistance of the soil, a tuberculous infection, previously latent, is brought into renewed activity. The deleterious effect of syphilis in its relation to tuberculous *development* is frequently *accentuated* by its influence upon the *subsequent course* of the pulmonary affection.

The advent of tuberculous manifestations shortly after the acquirement of syphilis is often followed by rapidly advancing infection, with a fatal termination. It is extremely doubtful, however, if syphilis of long standing is capable of exerting any special influence, either in the development or in the course of a later tuberculous infection. It has been claimed by some that tuberculosis, as a rule, exhibits a slow and benign type among old syphilitics. For this reason a certain retarding influence upon the evolution of tuberculous changes has been attributed to the specific disease. It is quite likely, however, that among such patients the diminished activity of the tuberculous infection is dependent to some extent upon the physiologic conditions common to more advanced adult life.

The **influence of syphilis upon a previously acquired tuberculosis** has seemed uniformly unfavorable. That extremely disastrous

consequences should follow the contraction of syphilis in the midst of an active tuberculous involvement is perhaps to be expected on account of its profound constitutional effect, together with the added element of mental distress. In addition to the physical debility and worry engendered, a not uncommon factor of unfavorable moment consists of the derangement of digestion occasioned by the necessity of unremitting medication. This is sometimes demanded in heroic doses almost regardless of stomachic disturbance. In the majority of cases, clinical experience amply substantiates the unfortunate effect of syphilis upon the course of pulmonary tuberculosis. Instances are by no means uncommon, however, in which the influence of a syphilitic infection, ingrafted upon an antecedent tuberculosis, has not proved entirely unfavorable. Exceptional cases have been reported from time to time, showing a conspicuous improvement stamped upon the clinical picture of pulmonary tuberculosis following the combination of the two infections. Several times I have observed a perceptible change for the better in the general aspect of the pulmonary invalid, a few months after the development of syphilis. I recall the case of a young consumptive of twenty-one who signally failed to improve during six months' residence in an appropriate climate under the personal supervision of a skilled clinician. Subsequently the patient came under my observation shortly after the development of the initial lesion. The following appearance of secondary manifestations suggested a marked virulence of the syphilitic taint. The activity of the tuberculous infection and the depraved general condition, together with the *history* of a progressive decline, apparently suggested the utter hopelessness of the case. Upon the continued exhibition of specific medication an astonishing improvement was manifested until an entire arrest of the tuberculous process was eventually secured. In view of the unfavorable history, prior to the onset of syphilis, the conclusion is possible that the recovery of the patient was largely influenced by the development of the later infection. While in such cases complete proof is necessarily lacking to establish a direct antagonistic influence of the syphilitic upon the tuberculous infection, the evidence appears conclusive that fibrosis is occasionally favored to some extent following the continued exhibition of specific medication.

The modifying action of tuberculosis upon an already existing syphilitic taint is also worthy of consideration by careful therapeutists. Many times I have been surprised by the *reappearance* of syphilitic manifestations among *consumptives*, who presented the history of a more or less remote specific infection and a prolonged period of rational medication. The previous quiescence of the clinical manifestations in such cases suggests a complete control of the infection for several years preceding the development of pulmonary tuberculosis. Upon the advent, however, of the latter disease, the physical debility and emaciation undoubtedly became instrumental factors in the recurrence of syphilitic symptoms. These have usually appeared as local lesions upon the skin or in the throat. Several well-defined cases of cerebral syphilis have been observed among my pulmonary invalids, who, through habits of dissipation, or by virtue of other excesses, were unable to attain satisfactory progress in the effort to improve nutrition. The thought has been suggested that the appearance of the tuberculosyphilids and the hybrid affections of the larynx, pharynx, or tongue in some cases is due to the

influence of the tuberculous infection, with its attending debility and malnutrition in arousing a dormant syphilitic taint. It is believed by laryngologists that the tendency to tubercle is favored by previous syphilis of the larynx, and it does not appear unreasonable to suppose that the implantation of tubercle bacilli upon a syphilitic soil should result in the development of lesions exhibiting to some extent the appearance of each infection. Marshall and other syphilographers have called attention to the frequent erroneous construction placed upon the presence of tubercle bacilli in lesions of doubtful character. When the nature of the local manifestations are such as to render obscure the origin of the infection, the presence of tubercle bacilli in the scrapings does not constitute positive evidence as to a *sole* tuberculous origin. Aside, however, from the direct ingrafting of tuberculosis upon local areas of syphilitic infection, evidence is not wanting, as stated, to substantiate the influence of tuberculosis, with its accompanying constitutional impairment, in favoring the reappearance of specific lesions.

The **differential diagnosis** of syphilis exhibiting well-defined thoracic manifestations and pulmonary tuberculosis is often exceedingly obscure. A close similarity is not infrequently observed in the subjective symptoms and physical signs. This resemblance may include the methods of onset, the existence of cough, expectoration, emaciation, fever; and the physical evidences of consolidation, softening, cavity formation, chronic bronchiectases, or fibrosis.

In many cases of pulmonary syphilis, the clinical picture is, in fact, identical with that of pulmonary tuberculosis save for the absence of tubercle bacilli in the expectoration. Without search for tubercle bacilli no suspicion, as a rule, is entertained by the physician as to the character of the infection. When the examination of the sputum is not practised as a routine measure, it is inevitable that cases of pulmonary syphilis will be overlooked, and that patients will be sent to climatic resorts with a diagnosis of tuberculosis. I have observed a few patients of this class in whom suspicion as to the syphilitic nature of the infection was aroused by the absence of bacilli, and confirmed by the application of the therapeutic test. The presence of tubercle bacilli in the sputum is not always sufficient to exclude entirely the syphilitic origin of the pulmonary condition. Several times I have had occasion to note the remarkable paucity of tubercle bacilli, although present after long searching, in patients exhibiting characteristic subjective and objective signs of an active pulmonary tuberculosis. A disproportionately small number of bacilli contained in the copious expectoration of an intractable bronchitis or in the presence of pulmonary excavation should awaken suspicion as to the possible underlying syphilitic nature of the infection, upon which an incipient tuberculosis may have been ingrafted. The same is true of an absence or a pronounced scarcity of bacilli accompanying extensive fibrosis. While the evidence in these cases is by no means conclusive, the wisdom of a searching inquiry to secure either the admission of syphilis or the recognition of other manifestations is apparent. It should be emphasized that syphilitic disease of the lung, either alone or in combination with tuberculosis, is far more frequent than practitioners have been prone to acknowledge. Generally speaking, in pure pulmonary syphilis there is less tendency to temperature elevation than in tuberculosis, less diarrhea, irritability, and acceleration of the pulse, night-sweats, or emaciation. In other words, syphilis, as a rule, is less

frequently associated with mixed infection than is tuberculosis, which accounts for the diminished temperature elevation and the usual absence of septic symptoms in the former disease. It is true, however, that some cases are observed in which the temperature elevation is quite out of proportion to the degree of pulmonary involvement. The persistence of fever, despite a prolonged maintenance of systematic management in cases exhibiting *exceedingly incipient infection,* is sometimes suggestive of the possibility of a syphilitic taint.

The course of pulmonary syphilis is often protracted to a degree, patients sometimes exhibiting an astonishing tolerance for the infection in the presence of extensive structural change. In doubtful cases recourse should be taken to the tentative employment of antisyphilitic treatment and the specific medication subsequently increased according to the therapeutic indications. The relation of pulmonary syphilis and tuberculosis is further discussed on page 296.

PART VI

PROPHYLAXIS, GENERAL TREATMENT, AND SPECIFIC TREATMENT

SECTION I

PROPHYLAXIS

CHAPTER LXXXII

RECIPROCAL RELATIONS OF CONSUMPTIVES AND SOCIETY

No argument is needed to substantiate the assertion that the prevention of consumption has been for years the most vital sociologic and economic problem of all civilized races. The wide-spread distribution of the disease among the *masses*, the peculiar conditions under which it is disseminated, its high rate of mortality, its demonstrable preventability and curability, all furnish convincing testimony as to the overwhelming necessity of aggressive effort toward its limitation and control.

The former apathetic recognition of the direful significance of consumption has been supplemented, during the past decade and a half, by an active educational and governmental agitation throughout the world toward its restriction. As a result of the energetic campaign already instituted, the way has been prepared for the irresistible advance of the organized forces of prevention against this common enemy of mankind. The ravages of a veritable scourge are becoming diminished, and hope may perhaps be entertained of a complete subsidence of the disease, as obtained in Europe with leprosy, a kindred affection, after the middle ages. A great deal that is highly commendable and fraught with far-reaching beneficent results has been accomplished, but there remains much to engross the attention and stimulate the activities of phthisiosociologists. The present status of the crusade against tuberculosis is too well known to clinicians and students of economic conditions to warrant repetition. Recent literature has been replete with the reports of the proceedings of societies for the prevention of consumption, suggestions concerning the social aspects of the disease, advices as to its administrative control, recommendations regarding the best manner of conducting an educational propaganda, reports of committees authorized to investigate conditions, reiterations of important individual precautions, and finally personal appeals from essayists in advocacy of more or less coercive measures of prevention.

In a work devoted essentially to the clinical rather than to the social features of tuberculosis, it is idle to attempt an exhaustive consideration of the many aspects of general and individual prophylaxis. The academic recital of the almost infinite phases of the problem of prevention, even if, perchance, not entirely familiar to a portion of the readers, would scarcely fall within the scope of this book, as the tedious details of such an inquiry do not entirely harmonize with a predominating endeavor toward clinical study.

It is designed to present a brief exposition of the trend of recent prophylactic endeavor, to review the generally accepted preventive measures pertaining to society, as well as to the individual, and to call attention primarily to the trust imposed upon the *family physician*, who *constitutes by far the most responsible agent for the restriction and control of consumption*. It also is desired to emphasize, both upon humanitarian and economic grounds, the obligation of the profession and of society toward those *already afflicted* with the disease, no less than toward the body politic. This phase of the subject has hitherto received but comparatively little attention. During recent years the organized work of antituberculosis associations has been devoted chiefly to the awakening of public interest and the adoption of effective prophylactic measures. Such laudable efforts, wherever systematically conducted, have resulted in a reduction of the mortality-rate and in the education of society to a more or less intelligent conception of the nature of the affection. While this inures greatly to the protection of future communities, to what extent the welfare of the *consumptive* is being subserved by concerted medical interest is justly subject to inquiry.

It is apparent that the recent *phthisiotherapeutic* thought has been directed very largely to the interests of pulmonary invalids included in the category of *incipient* cases, to whom alone are offered a welcome in most institutions supported by private and public benevolence. With no desire to reflect upon the great utility of such sanatoria open to very early cases, it is none the less opportune to mention the fact that patients of this character do not constitute such a menace to society as the more advanced cases, and demand far less the personal supervision of a resident physician, with his retinue of subordinates. While an elaborate systematic control is often accorded to incipient cases, and incidentally unusual facilities for recovery, the same practical and sympathetic consideration is not extended to those exhibiting more pronounced infection. Advanced cases are denied admission to nearly all sanatoria and are also *persona non grata* to all municipal hospitals. It cannot be doubted that these unfortunates should be permitted to profit from the recent agitation concerning consumption. While they are privileged to be registered at headquarters and to receive instructions from some responsible medical source, they are forced to appreciate the fact that they constitute a source of immediate danger to other members of the family. These invalids, by virtue of their advanced condition, are denied those advantages which are freely bestowed upon others, who are *less worthy* upon the score of their actual needs, and constitute, to a subordinate extent, elements of danger to the public. In this connection let it be understood that it is the consumptive, with unmistakable evidences of *advanced* infection, who represents the chief source of further bacillary distribution. It is for such individuals especially that disciplinary control is indicated and for whom instructions

should be provided. Proper efforts addressed to invalids of this class cannot fail to yield a satisfactory return.

The practical results possible of attainment in the effort to restrict tuberculosis must depend to a great extent upon the willing, intelligent coöperation of the patient. Public protection can *never* be secured in *full* through legislative enactment, or attempts toward municipal control, unless the invalid from whom emanate the agents of infection *strives conscientiously to perform his part.* Faithful service in this respect, even in the absence of a suitable environment, may be obtained by instructive persuasive appeals, reinforced, when necessary, by drastic expedients for the ignorant or vicious. Any action bearing upon the preservation of the public from tuberculosis should be attended by an effort to promote the welfare of the consumptive class, especially among the poor. This involves the rendering of *substantial aid* to those exhibiting reasonable prospects of recovery, and adequate provision for the *care and maintenance* of advanced cases. At the same time the interests of the community pertain to the removal, from its very midst, of destitute invalids constituting an oppressive burden to their families, if not to society, and who, through their ignorance and inability to observe precautions, become a constant menace to the well. There is demanded some well-directed and far-reaching system of education and control the influence of which, to be most effective, must be through the medium of daily example and practical supervision. It is with reference to these broad considerations that certain fundamental data of an etiologic nature are adduced to demonstrate the general principles which should govern a systematic prophylaxis.

Our present conception of the etiology and pathology of phthisis establishes conclusively its communicability, preventability, and curability.

Consumption is *communicable* only within certain broad limits. Its transmission from one person to another does not take place as a result of direct exposure after the manner of a few contagious diseases. Infection results not from the mere presence of the pulmonary invalid, but solely from neglect to observe necessary precautions. A wide dissemination of the bacillus constitutes a source of danger chiefly to those rendered susceptible by virtue of age, environment, occupation, previous disease, and other predisposing causes. Thus, in the development of tuberculosis, the character of the soil as an etiologic factor is equally, if not more, important than the presence of the microorganisms. The development of the disease is known to be exceedingly slow and incremental in character, and only after repeated infections have been acquired and the individual resistance perceptibly lowered, are recognized the clinical manifestations of the disease.

As consumption is known to be *preventable* to a great extent, there is imposed a direct obligation upon society to secure all possible means of prevention. It is primarily essential that uniformity of method be instituted as far as practicable in different parts of the country. Adherence to a general concerted plan of action, representing both an active educational propaganda and a campaign of responsible control should prove peculiarly effective and without prejudice to invalids or localities. The responsibility for the prevention of consumption rests directly with the medical profession in its advisory capacity on matters pertaining to public health. The physician, however, in the execution

of so responsible a trust, should be mindful of his duty to consumptives as well as to society. Fortunately, a sustained and conservative regard for the rights and requirements of each class need inflict no hardship upon the other. Their interests, though apparently somewhat divergent, are, as a matter of fact, almost identical, permitting relations of important reciprocity. It is incumbent upon the medical profession to recognize the claims which each has upon the other, to adjust apparent differences and insure the adoption and effective execution of rational measures pertaining to inspection and control.

A proper administrative supervision tends to create among the masses a just conception of the manner in which the infection may be conveyed, a comprehension of the comparatively slight dangers if ordinary precautions are observed, but an acute appreciation of the necessity of complying with detailed instructions. A diffusion of elementary knowledge regarding the more important etiologic features of consumption is demanded, on account of the frequent display of apathetic indifference or ignorance, and the occasional exhibition of an immoderate popular attitude. The advocacy of such extreme procedures as the obligatory isolation and segregation of consumptives, the placarding of houses, the enactment of laws prohibiting marriage, the compulsory cremation of the dead, and similar considerations have served only to inspire exaggerated feelings of alarm. As reflecting a laudable degree of interest in medicopublic affairs, these features are worthy of serious consideration, if not of commendation. It appears, however, that the promulgation of such opinions at this time is not warranted by demonstrable etiologic facts, and serves to impart distorted ideas, thus adding to a somewhat intolerant public sentiment. While all immoderate statements tending to inspire alarm must be avoided, enthusiastic support should be accorded to health authorities along the lines of preventive medicine. Rational measures for the restriction of consumption should be rigidly enforced in every State. While the burden of the consumptive must not be made harder to bear by reason of erroneous popular impressions, it is apparent that the safety of the public must be exalted above the pride and sensitiveness of individuals. A judicious and intelligent consideration of the rights of each enforces a conviction as to the wisdom of compulsory municipal control and the elaboration of a systematic campaign of popular education.

In addition to the communicability and preventability of consumption, the State must needs take cognizance of its *curability*. The very fact that the disease so often offers a possibility of cure, by which is meant a restoration of active usefulness, emphasizes the direct obligation to make suitable provision for the care and maintenance of those unfortunates who are incapable of self-support. Substantial aid from this source will result in the saving of life and health, with an enormous alleviation of suffering. The duty of society relates but little more to the preservation of communities than to provision for the comfort and welfare of her invalid class, who, prior to their misfortune, contributed so largely to the prosperity of the State. By this means there is afforded a supervisory control of those unable in their ordinary environment to observe sanitary precautions and who become, with advancing infection, a distinct element of danger.

Practical consideration for the indigent pulmonary invalid is also demanded of society upon economic grounds. With proper assistance

the consumptive is prevented from becoming permanently dependent upon others and often is enabled to resume the rôle of bread-winner for the family. In like manner the State is permitted to add substantially to its resources by preserving one of its most valuable commodities—the earning power of labor. If it is deemed obligatory to provide institutions for the non-consumptive poor, frequently reduced to poverty through their own responsibility as a result of shiftlessness, dissipation, or inherited perversion, who are destined never to regain social cast or citizenship, it would appear imperative to assist those who have suffered ill health through unnecessary exposure for which society is to some extent responsible.

The duty of the State to provide assistance for unfortunate but worthy consumptives is further emphasized by the fact that a large majority of such patients are victims of delayed or erroneous diagnosis. While this reflects directly upon the family physician, it is also true that society must be held responsible for errors on the part of a profession over which, in different States, it assumes to exercise jurisdiction and control. As a general rule, consumption may be regarded as a curable disease only with reference to *early* cases. Failure to appreciate fully the significance of rational symptoms, or to recognize and interpret accurately the physical signs of incipient stages, has occasioned an enormous annual sacrifice of human lives, to say nothing of the suffering incident to prolonged illness. The actual responsibility and culpability of the family physician in these cases is accentuated by the undeniable truth that such disastrous results are often entirely without extenuation. In addition to the grievous results of mistaken diagnosis at the hands of reputable practitioners, other abuses of a still more flagrant nature are frequently heaped upon the unfortunate victim of consumption. Society, which sometimes encompasses the regular and legitimate practice of medicine with embarrassing restrictions, yet permits the unsuspecting invalid to become the non-defensive prey of ignorant and unscrupulous charlatans. While many forms of quackery have been overlooked and the advertisement and sale of patent medicines containing alcohol and various narcotics have been permitted, the State, by virtue of its failure to enact repressive legislation or to enforce existing laws, has become indirectly responsible for the lack of public health.

From the foregoing considerations it is apparent that effective means should be employed to satisfy the respective claims of society and her invalid class. The conduction of an educational propaganda to be peculiarly effective must emanate from some recognized responsible source and be attended by a coöperation of all organizations interested in public health. It is essential that a concerted campaign should be outlined, under federal authority, or be conducted by a parent national organization, exercising a dominating control over the work done in the individual States. The establishment of a national bureau of public health, endowed with supervisory authority over all State and municipal health officers is eminently practicable. By this means much may be accomplished along the lines of preventive medicine, which at present is difficult of practical achievement. The scope and usefulness of the National Association for the Prevention of Tuberculosis, as well as certain State and municipal organizations along similar lines, will be later discussed.

Any concentrated effort toward the restriction of a social disease

known to be communicable, preventable, and curable should be directed to the *limitation of exposure*, the *prevention of infection* in *spite* of exposure, and the *restoration of health* through the *arrest* of the *tuberculous process after* infection *has taken place*. Under these three headings may be embraced the broad duty of the Commonwealth in the endeavor to preserve the public health.

Measures to prevent exposure must be aimed at the contagium, which constitutes the primary source of the disease, *i. e.*, the tubercle bacillus. Efforts to limit infection must be directed toward a variety of secondary causes, which combine to so diminish the powers of resistance as to create a predisposition on the part of the individual. It has been explained that the implantation of bacilli sufficient for the production of clinical manifestations is only possible, as a rule, from prolonged exposure and a certain receptivity of the soil. In the light of our modern knowledge it appears that an active spectacular campaign against the *seemingly ubiquitous agent* of infection alone, is quite impracticable. The prevention of consumption, to be really effective, must be based upon other conceptions than the one idea of exposure after the manner of leprosy or a few intensely contagious diseases. For the legitimate control of tuberculosis there should not be contemplated a "*crusade*" against the offending microbe under the delusion that a war of extermination will suffice to obliterate the disease. Practical results are to be acquired from a rational insistent demand for the *betterment of all conditions possessing etiologic significance*. Much has been printed of late as to the paramount necessity of the destruction of the bacillus in order to forestall the "annihilation of consumption." Essayists have waxed eloquent in their predictions concerning the "wiping out" of the disease, its "stamping out" or "blotting out," and "its eradication from the face of the earth." In this connection it is pertinent to suggest that the ultimate effacement of tuberculosis can take place only as a result of a broadly conceived and well-sustained movement, which takes cognizance of *each factor* capable of influencing the spread of the disease. The incidental limitation of its ravages through the extension of substantial aid to a class of citizens in every way worthy of practical assistance constitutes an important feature of a campaign, to be conducted through effectiveness of organization and thoroughness of preparation. Among other features there is indicated a comprehensive and perfected system of public philanthropy, through which means enduring economic results may be secured.

The prophylactic and humanitarian efforts of society with reference to consumption should embrace the following methods of procedure.

1. Compulsory notification and registration of all cases of pulmonary tuberculosis.

2. A personally conducted supervision of the consumptive and his environment, including an elaborate system of education.

3. The extension of material aid, when necessary, according to the varying needs and requirements of differing classes.

4. The dissemination, to the general public, through the medium of various channels, of authentic official information regarding the prevention of consumption.

5. The administrative control of all important factors entering into the problem of etiology and prophylaxis.

CHAPTER LXXXIII

COMPULSORY NOTIFICATION AND REGISTRATION

It is necessary to know precisely *where* and *when* the disease exists in order to inaugurate any systematic and direct supervision, without which an effective administrative control of tuberculosis is utterly impossible. Some form of registration, therefore, is absolutely essential as an *important preliminary* to successful municipal efforts toward prevention. A considerable difference of opinion has been entertained regarding the relative merits of voluntary and enforced notification, objection having been made to registration without the consent of the patient or family. In view of the comparatively slight difficulty experienced in maintaining strict privacy, opposition has of late diminished very perceptibly.

It is quite apparent that the effectiveness of notification as a factor in prophylaxis is dependent altogether upon the completeness of its execution. Voluntary reports, though inspired in individual instances through highly conscientious motives, are nevertheless sadly incomplete in their general application. Upon the other hand, the value of compulsory notification depends not upon the enactment of ordinances to this effect, but upon the existence of such professional and popular sentiment as will demand its rigid enforcement. The logical solution of this problem is, therefore, through the *education* of the profession and the public, before attempting administrative measures which may appear unnecessarily drastic.

Even faithful compliance, whether voluntary or compulsory, with regulations governing notification and registration, is of no practical avail unless followed by further organized efforts on the part of the municipality toward the restriction of the disease. It is useless, therefore, to advocate notification in large cities unless the health authorities are in a position to carry the campaign of education and supervision into the very homes of those afflicted. This involves no publicity and implies no such extreme measures as the placarding of houses, isolation, or personal humiliation. There need be contemplated no interference with personal rights, family ties, social conditions, or business pursuits, unless rendered necessary by repeated and intentional infractions of prescribed regulations. No hardship whatever is inflicted upon the consumptive or family, but opportunity is offered to receive instructions from a definitely responsible source. This inures greatly to the benefit of the invalid and those about him, while society profits from the additional facilities afforded for the maintenance of rational supervision.

There should be imparted *competent instruction* as to the nature of the disease, and as to the *dangers* of contagion in the *absence* of precautionary measures. No *less important* than the inspection of apartments, or disinfection of rooms and clothing, is the *adoption of therapeutic* efforts, the *reassurance* of others when necessary, *examinations* of *members* of the *family*, investigations of *predisposing* conditions, and *free reports* of sputum analyses. In fact, almost the entire system of municipal control subsequently to be elaborated is contingent upon the knowledge of the existing centers of possible infection. Assuredly such information cannot be obtained solely from the mortality records,

but rather from the willing coöperation of physicians in reporting all cases of *existing* disease. The element of compulsion, though not primarily essential and of less value than an awakened public sentiment, is yet demanded in order that means may be provided for the detection and punishment of offenders. This is rendered entirely practicable by a comparison of the death certificates with the previous registration of tuberculosis. Thus a check is permitted upon the honesty and accuracy of individual reports.

It does not appear that valid objection could be made in any community against the institution of measures of this kind calculated to conserve the interests of the invalid as well as the public. Yet in some localities even in spite of municipal ordinances governing notification, the law "is more honored in the breach than the observance." With the increasing enlightenment of the people there is but slight excuse for further resistance to the policy of registering living cases of consumption as well as the dead. It is incomprehensible that civic pride can tolerate the ostrich-like habit of hiding the head to real facts concerning the existence of consumption and suffer delusions of terminology to increase the actual dangers of the disease.

It is significant that the most gratifying results in the prevention of tuberculosis have been secured wherever the laws pertaining to notification have been strictly enforced. New York has set an example to the entire world, not only in the early adoption of registration laws, but in a demonstration of the value and practicability of their compulsory observance. In 1893 notification became partly voluntary and partly obligatory in that city. Only in public institutions was this compulsory, but a strong effort was made to create a professional sentiment favoring voluntary reports to the Department of Health. In spite of somewhat strenuous opposition, the spirit of administrative control after a few years became more firmly established. Through the substantial influence of a medical advisory board, comprising some of the most eminent physicians in New York, there were inculcated gradually more sensible and progressive views among the profession and public. In this manner greater confidence was inspired as to the correctness of the advanced position assumed by the Department of Health under the aggressive leadership of Dr. Biggs. During the first year 4000 cases of consumption were reported and 500 specimens of sputum submitted for bacteriologic examination. In 1897 an amendment to the Sanitary Code was adopted, requiring the reporting of all cases. More than 25,000 cases of tuberculosis are now reported annually, and an approximately equal number of free examinations of sputum are made. While a certain small proportion of consumptives must remain unregistered, it is probable that more than three-fourths of all cases are recorded in the Health Department and subjected to the advantages of supervisory control. The practical results obtained in the diminution of consumption in New York are particularly enlightening. In no other city in the world has there taken place any reduction of the death-rate from tuberculosis at all comparable to that achieved in our American metropolis, in spite of the density of her population in tenement districts and the direst poverty among a large class of people of foreign birth. The fall in the mortality rate during the past twenty years is estimated at about 40 per cent., inclusive of all cases of tuberculosis. No more striking commentary can be afforded as to the benefi-

cent and practical results capable of attainment in the supervision of a disease to a large extent preventable.

In England the Government, for the purposes of observation and educational review, has permitted the enforcement of compulsory notification for a limited time in a single large city (Sheffield). Scurfield, Medical Health Officer to the City of Sheffield, reports that the Compulsory Notification Act has been in operation since November 1, 1903, without any organized opposition on the part of the public or the profession. Voluntary notification had been in vogue during the preceding four years. The general attitude in England must be regarded at present as one of reserve and conservatism. This is perhaps occasioned in part by the fact that many of the most eminent medical authorities have not been in strict accord concerning the expediency of obligatory notification. Sir Richard Thorne, the Medical Adviser to the Local Government Board of Great Britain, in his lecture upon the Administrative Control of Tuberculosis one year after the adoption of compulsory notification in New York city, definitely opposed such a procedure in England, regarding it to be completely unjustifiable.

In Scotland, where approximately 10,000 people die annually from some form of tuberculosis, a more determined effort toward administrative control has been established. During the thirty years from 1871 to 1901, the death-rate from phthisis, according to Bramwell, has been reduced from 278 to 153 per 100,000. In the latter part of 1906, compulsory notification was unanimously adopted in Glasgow, a system of voluntary notification having been in operation during the preceding six years. In other cities a similar voluntary system is now in vogue, but through the noteworthy efforts of Bramwell, McKenzie, Phillips, and Dittman, this is being more generally regarded as an unfortunate compromise, if not a vicious makeshift.

In Ireland, according to the reports of Sir John W. Moore and Edward J. McWeeney, the magnitude of the tuberculosis problem is illustrated by the fact that the death-rate has recently reached the maximum of 2.9 per 1000 of the population, representing the deaths of 12,694 persons during the year. Only in the years 1880, 1897, 1898, and 1900 has such a high mortality rate been previously attained. The death-rate in England is reported to have fallen, since 1864, from 3.3 per 1000 to 1.7; in Scotland, from 3.6 per 1000 to 2.1, and yet in Ireland to have risen from 2.4 per 1000 in 1864 to 2.9 in 1904. That the Irish people are awakening to the enormity of the danger is evidenced by the fact that in 1906, at a meeting of the Dublin Branch of the National Association for the Prevention of Consumption, a resolution was adopted providing for the adoption of a system of compulsory notification.

In Denmark, according to Vilhelm Maar, 20,000 people out of a total of 2,500,000 inhabitants are at present afflicted with tuberculosis, and approximately 8000 new cases are developing annually. In compliance with the suggestions embodied in the report of the Parliamentary Commission appointed in November, 1901, to investigate conditions and propose remedial measures, all physicians are compelled to report cases of existing tuberculosis coming under their observation as well as the deaths.

In Australia, which possesses a dry sunny climate with a comparatively small population exhibiting but little poverty, the death-rate

from tuberculosis is reported by Armstrong as 29 per cent. less than in England in 1904. The mortality rate has become progressively reduced since 1885. Compulsory notification has been in force in parts of Australia since 1898. Neglect to comply with notification laws is subject to heavy penalty. Gratifying results have been secured in Adelaide, Melbourne, and Sydney.

In Roumania, Mitulescu reports that the death-rate from tuberculosis in the large cities is 3.6 per 1000 people, the rate in Bucharest being particularly high. Since 1901 effective efforts have been instituted to introduce compulsory notification, work along these lines being accorded active support by the profession and public.

Great interest in the campaign against tuberculosis is manifested in Norway, Holland, Switzerland, and Belgium. Compulsory notification is admitted to be a decided success in Norway, where it has been carried out since 1901, and is earnestly advocated by the leaders of the profession in other countries. Holmboe, of Christiana, reports that obligatory notification no longer meets with resistance, that early exaggerated notions as to the fear of infection have subsided, and that administrative control is meeting with growing favor on account of the increasing enlightenment of the people. Dr. Carriere, of Berne, reports a progressive diminution in the mortality rate of pulmonary tuberculosis since 1883, despite an increase in the total mortality from other tuberculous affections.

In Germany it is estimated from the official data furnished by the Imperial Health Office that from 110,000 to 120,000 people die annually of consumption. In nearly all cities the statistics show a gratifying diminution in the mortality rate of tuberculosis of approximately 40 per cent. during the past thirty years. Many municipalities have adopted regulations enforcing obligatory notification and registration. Compulsory notification, according to Glasenapp, President of Police, Rixdorf, is soon to be introduced in that city for all cases of open pulmonary or laryngeal tuberculosis. The unfortunate results of the present lack of compulsory notification are greatly minimized, however, by the work of the inquiry bureaus and tuberculous dispensaries. Kayserling, Secretary General of the Central Committee for these organizations in Berlin and suburbs, reports that detailed notification is obligatory upon the nurses connected with the service, and that effective measures of prevention and supervision are immediately instituted by the inquiry stations. In France the principle of compulsory notification at first met with considerable opposition. In 1899 the Academy of Medicine in Paris appointed a special commission to submit propositions regarding the administrative control of tuberculosis. Compulsory notification was resisted strongly at that time as being uncalled for and distinctly objectionable.

In recent years a vast amount of good has been accomplished by the Permanent Committee for the Prevention of Tuberculosis in France, public interest having been awakened with reference to all important features of prophylaxis.

While many American cities have emulated the example of New York in adopting regulations requiring reports of tuberculosis to health authorities, but comparatively few compel their actual enforcement. In Philadelphia notification was recommended by the County Medical Society in 1893, but failed of inauguration until 1905. In Boston com-

pulsory registration has been in force since 1900. Of the 86 largest cities of the United States, according to a report made by Wm. H. Baldwin and other members of a committee appointed by the National Association for the Prevention of Consumption, 57 had enacted laws by the early part of 1906, pertaining to compulsory registration. Of these 57, nearly one-fifth passed their ordinances during 1905, as will be seen by the following table presented by the committee:

City.	Date of Law.	Population, 1900.	Forms to be Reported.
New York City	Jan. 18, 1897	3,437,202	All
Camden, N. J.	Dec. 27, 1897	73,935	All
Cincinnati, O.	Aug. 19, 1898	325,902	Not stated
Elizabeth, N. J.	March 6, 1899	52,130	Not stated
Boston, Mass.	May 1, 1900	560,892	Pulmonary
Buffalo, N. Y.	1900	352,387	Not stated
Rochester, N. Y.	1900	162,608	Not stated
Trenton, N. J.	Jan. 8, 1901	73,307	Pulmonary
Bridgeport, Conn.	April 23, 1902	70,996	Pulmonary
Lowell, Mass.	Sept. 1902	94,969	Pulmonary
Worcester, Mass.	Oct. 6, 1902	118,421	Pulmonary
Louisville, Ky.	Oct. 1902	204,731	Not stated
Atlanta, Ga.	Oct. 1902	89,872	Not stated
Oakland, Cal.	1902	66,960	Pulmonary
Providence, R. I.	Jan. 15, 1903	175,597	All
Hartford, Conn.	March 4, 1903	79,850	All
Cambridge, Mass.	March 11, 1903	91,886	Pulmonary
Omaha, Neb.	June 30, 1903	102,555	Not stated
San Francisco, Cal.	Oct. 27, 1903	342,782	All
Los Angeles, Cal.	Oct. 1903	102,479	Not stated
Memphis, Tenn.	1903	102,320	Not stated
St. Paul, Minn.	Jan. 1904	163,065	All
Minneapolis, Minn.	Aug. 26, 1904	202,718	All
Reading, Pa.	Sept. 1, 1904	78,961	All
Somerville, Mass.	Oct. 6, 1904	61,643	Pulmonary
*Des Moines, Ia.	Oct. 28, 1904	62,139	All
Springfield, Mass.	Nov. 1, 1904	62,059	Not stated
Cleveland, O.	Feb. 3, 1905	381,768	Not stated
Youngstown, O.	Feb. 6, 1905	44,885	Pulmonary
Yonkers, N. Y.	Feb. 1905	47,931	Not stated
Paterson, N. J.	March 3, 1905	105,171	Pulmonary
*Salt Lake City, Utah	March 9, 1905	53,531	Pulmonary
Grand Rapids, Mich.	March 1905	87,565	Pulmonary
St. Louis, Mo.	April 7, 1905	575,238	Pulmonary
*Baltimore, Md.	April 8, 1905	508,957	Pulmonary
†Philadelphia, Pa.	April 27, 1905	1,293,697	Pulmonary
New Haven, Conn.	April 1905	108,027	Not stated
*Milwaukee, Wis.	May 15, 1905	285,315	All
Fall River, Mass.	June 13, 1905	104,863	Pulmonary
Waterbury, Conn.	Sept. 5, 1905	45,859	All
†Pittsburgh, Pa.	Sept. 10, 1905	321,616	All
New Bedford, Mass.	Nov. 8, 1905	62,442	Not stated
Columbus, Ohio.	1905	125,560	Not stated
Erie, Pa.	Jan. 1, 1906	52,733	Not stated
Chicago, Ill.	Jan. 1, 1906	1,698,575	All
Lawrence, Mass.	Feb. 19, 1906	62,559	All
Peoria, Ill.	Feb. 20, 1906	56,100	Not stated
Detroit, Mich.		285,704	Not stated
Holyoke, Mass.		45,712	Not stated
Seattle, Wash.		80,671	All
Wilkes Barre, Pa.		51,721	Not stated
Troy, N. Y.		60,551	Not stated
Indianapolis, Ind.		169,164	Not stated

*State law

†State law; enforcement in this city begun about this time.

The only cities of over 125,000 population which had not passed ordinances requiring notification were Chicago, New Orleans, Newark, Jersey City, Kansas City, and Denver. It is frequently urged by some that compulsory notification is especially indicated for Denver on account of the influx of imported cases, and the possible development of an indigenous disease seriously imperiling the future of the community. While denying that for such alleged reason an *unusual* necessity exists in Colorado for a tuberculosis crusade, it is admitted, nevertheless, that measures for the restriction and control of tuberculosis should be rigidly enforced in Denver as elsewhere. That such is not the case is indeed a reflection upon the profession, unextenuated by the existence of favorable climatic conditions, the absence of an overcrowded population, or the relatively insignificant amount of poverty. Irrespective of locality or other inherent etiologic factors there should be observed in all cities compulsory notification as preliminary to a campaign of education and supervision. This should embrace all cases of tuberculosis, include each change of dwelling, and become obligatory upon the attending physician, the nurse, the head of the family, and the owner of the house.

CHAPTER LXXXIV

THE SUPERVISION AND EDUCATION OF THE CONSUMPTIVE

The pulmonary invalid, in the *absence* of certain precautions relative to daily habits, is a direct menace to the family and the public, but strict conformity to prescribed instructions entirely *removes* all elements of danger. Upon these premises two conclusions are obvious. First, that society has the right to demand of the consumptive the most rigid observance of sanitary rules, and, secondly, that the victim of tuberculosis is entitled to receive from the health authorities systematic instruction with reference to the arrest as well as the control of the disease. The burden of action thus lies with the public in the *education* of the consumptive preparatory to any successful scheme of supervision. To this end public effort toward the restriction of the disease should consist primarily of such assistance as will secure a hearty recognition of reciprocal obligations. The methods to be employed in undertaking the education of the invalid are various. Certain well-defined groups of consumptives are recognized to whom are indicated separate and widely differing means of imparting knowledge.

In many instances the attending physician represents one of the most important channels by which information may be conveyed with the greatest likelihood of enlisting active coöperation. Unfortunately, the practical effectiveness of this method may be limited in its general applicability by the negligence of the physician. Too often the general practitioner either utterly fails to appreciate his responsibility in the matter, or neglects to impart detailed instruction solely on account of the time and trouble involved. In other cases the physician, although perhaps earnest and conscientious, may not be sufficiently informed to train

the patient in a proper manner. In many instances, however, according to the discretion of the health authorities, the personal instruction of the consumptive may be delegated to the physician in charge, but this, under no circumstances, should prevent the supplementary distribution of educational literature, in order to insure accuracy and thoroughness of observed precautions.

Among the more intelligent classes carefully prepared circular information, portraying in detail the necessary preventive measures, often suffices to impart to the invalid an adequate conception of individual responsibilities. Grateful and appreciative readers of such literature are not always found among the masses, particularly the wage-earners, who are often indifferent to their surroundings and careless in their habits. For these, educational leaflets of a more emphatic nature are demanded, and their contents should be adapted to the peculiar requirements of such a class. Such circulars of information should, above all, be clear, brief, concise, of simple phraseology, in effect more or less mandatory, without attempt at unnecessary explanation, and printed in various languages.

The work of responsible instruction must develop in the main upon duly authorized and specially trained assistants, working under the sanction either of the Health Department or of various charity organizations. Through the influence of personal contact and force of example, educated women serving either as visiting nurses or sanitary inspectresses, are enabled to inspire immediate confidence and secure intelligent coöperation. Thus the precautionary rules left for perusal are more likely to be understood and obeyed. Periodic visits, with systematic reports to higher authorities, result in the preservation of valuable records, through which means administrative control may become more effective and the official mind, if occasion requires, awakened to the necessity of coercive action.

Other means for the education of the consumptive are afforded through the medium of tuberculosis classes, free dispensaries, sanatoria, and the *various* methods of enlightening the *general* public, to all of which consideration will be given in the proper place.

Tuberculosis is essentially a *house* disease, however, and it is in the *home* that the vast majority of pulmonary invalids must receive their instruction and become subject to supervision. By far the most important feature of prophylaxis relates to the *disposal* of the *sputum* in the *sick-room*, and it is to this phase of the subject that especial attention must be directed.

It is essential that scrupulous care be taken to avoid contamination of clothing, bedding, furniture, rugs, floor, hands, lips, beard, or any other portion of the body with tubercle bacilli. In the act of coughing tiny invisible droplets of infective material may be forcefully distributed in all directions. For this reason it is important that the spray be arrested by some suitable medium held before the mouth at such a time. For this purpose paper napkins or pieces of gauze or old cloth are usually available, and should be immediately burned or deposited in a paper bag, paraffined envelop, reticule, or similar receptacle made of oiled silk or rubber. It is undesirable to make use of the handkerchief in endeavoring to prevent a possible dissemination of bacilli, but such practice is, of course, less objectionable and filthy than the habit of utilizing it at the time of expectoration. If the patient holds the handkerchief before the mouth when coughing, this should be folded

at once and set aside until cleansed in the manner to be described for all linen. In the absence of suitable material upon which to gather the droplet emanations from the mouth while coughing, the patient should be instructed to hold the hand before the lips and wash it at once. The lips should be carefully wiped with paper napkins or gauze, although in some cases preference is given to washing with a mild disinfecting solution. In this event the advantage accrues not so much from the nature of the solution, as from the thoroughness of cleansing. No handkerchief, gauze, or cloth should be used more than once for wiping the lips.

As a rule, the consumptive should be advised to dispense with his beard, especially if at all luxuriant. Nothing is more unsightly or unclean than an overhanging growth upon the upper lip of pulmonary invalids, unless it is the time-honored chin-whisker of our countrymen upon which may adhere particles of bacilli-laden sputum. If objection be made to the removal of the beard, it at least should be cropped very closely.

A proper receptacle for the sputum is of the utmost importance. It is essential that the expectoration should not be permitted to dry exposed to the air of the room, nor to soil by accident any article for which it was not intended. It should be deposited, without going astray, in earthen cups partly filled with water, in paper spit-cups, or upon pieces of gauze. Old-fashioned cuspidors upon the floor are an abomination not to be tolerated. In all instances the patient should deposit the sputum with the cup or other receptacle held closely to the mouth, in order to avoid scattering the agents of infection. Earthen cups used for this purpose should be cylindric in shape and provided with a cover. It is important that some means be taken to conceal the unsightly expectoration and prevent the entrance of flies, thus avoiding consequent distribution of bacilli to articles of food, as has been described. Under no circumstances should there be used hand cuspidors with an inclined upper surface terminating in a small aperture at the center, as it is inevitable that particles of adherent sputum will become dried upon the presenting upper portion. Caution should be exercised to prevent the retention of sputum in a similar manner upon the sides or edges of earthen cylindric cups. If paper spit-cups are used, they should be destroyed by fire, and if these are contained within a square tin box, the latter should be boiled daily. If pieces of cheese-cloth or gauze are employed, they should be folded immediately after expectoration, and deposited temporarily in a proper receptacle, as has been explained, and subsequently burned. If an ordinary earthen cup is used as a receptacle for the sputum, it is important that it should have a handle and be partly filled with water. It is unnecessary to employ disinfectants, provided proper attention is given to emptying and refilling the cup at frequent intervals. If a receptacle of this sort is used, the primary essential is that the sputum should be kept *moist* and *covered*. In cities with modern sewerage facilities the cup may be emptied into the water-closet. In other cases the sputum should either be boiled or exposed to a strong phenol solution for several hours.

An elaborate method for the sterilization of tuberculous sputum has been described by Kirkland and Patterson. The sputum is poured into an iron vessel, which is provided with a movable lid and has at the bottom

two steam jets which, in operation, give a circular motion to the contents. After the sputum has been emptied into the iron receptacle and the lid screwed down, the steam is introduced through the jets at the bottom to a pressure of fifteen pounds. After the sputum has boiled for twenty minutes it is allowed to cool, and is then drained into the sewer by the opening of a valve at the bottom of the sterilizer. The sputum-cups are cleaned in a somewhat similar manner. They are first suspended by their handles upon a series of horizontal brass tubes, which form the essential feature of a cage which, in turn, is lowered into the iron tank. Into this are admitted water and steam, the boiling being permitted for twenty minutes. The advantages of this method appear to be marked economy of time, greater safety in the handling of the cups, and more thoroughness than if washed by hand.

It is of the utmost importance that proper provision be made for the cleansing and sterilization of the linen. In the later stages of consumption, when the patient is completely bedridden, the danger of soiling the linen with infected sputum becomes exceedingly great on account of the physical exhaustion. In many cases the intellect is impaired more or less and the patient is totally unable to appreciate his status as a source of danger to others. The responsibility for a proper hygiene of the sick-room then devolves entirely upon the attendant. At such a time it is better that the sputum should be deposited upon pieces of cheese-cloth or gauze, rather than in sputum-cups, as these are often upset if permitted in the hands of the patient. The paramount consideration relates to the observance of the utmost cleanliness as regards the clothing, hands of the invalid, bed-clothes, floor, and rugs. The hands of the attendant, as well as the patient, should be kept absolutely clean at all hazards. All articles of soiled linen which are not to be destroyed, should be brought into immediate contact with a 5 per cent. solution of phenol or immersed for several hours in a solution of corrosive sublimate and subsequently boiled. The solution may be made by dissolving a dram each of corrosive sublimate and ammonium muriate in a gallon of water contained within a wooden bowl or tub. This solution may also be used for washing floors, walls, or wooden furniture. In institutions sterilization plants are essential for a proper cleansing of the linen.

The furniture of the sick-room should be as simple as possible. Draperies, lace curtains, velvet or plush furniture, and all articles likely to retain dust should be excluded. It is desirable to clean the room, if possible, only when the patient is out-of-doors. Care should be taken not to dust with feather-dusters or to sweep vigorously with a dry broom. The rugs should be cleaned in the open air, and dusting should be performed only with a moist cloth. There should be no carpet in the room occupied by a consumptive.

It is properly one of the prerogatives of health officials to supervise effective methods of disinfection of apartments, after the death or removal of the consumptive. Much has been written of late concerning the necessity of disinfecting such rooms and the contained furniture at public expense. The movement relative to the destruction or disinfection of all articles with which the invalid has come in contact has *extended* sufficiently to inspire on the part of certain students and educators an advocacy of cremation. It is well in this connection to call attention to the fact that the administrative control of tuberculosis pertains far

more to the supervision of the consumptive, and his immediate environment while he is *yet alive*, and *disseminating innumerable agents of infection*, than to the disposal of his body after the potent source of danger has ceased to exist. As a matter of fact, an insistence upon strict precautionary measures relating to personal cleanliness and the hygiene of the sick-room during life is of infinitely more importance than the disinfection of apartments and the destruction of their contained articles after death. It would appear, however, that both the profession and the public are educated more or less to a belief in the wisdom of rigid disinfection of apartments occupied by consumptives. Frequently, however, no particular concern is manifested as to their immediate presence in the family for prolonged periods. Disinfection of apartments by no means is to be deprecated, but the thought is suggested that in some instances the importance of this procedure is exaggerated. As suggested by Chapin, disinfection should not be regarded as an expiatory atonement for previous unsanitary sins. It is particularly to be recommended in crowded tenements exhibiting a sad deficiency of sunlight or fresh air, and occupied by the ignorant, impoverished, and sometimes the vicious. Disinfection, when done at all, should be practised in a most thorough manner, and may be performed by the burning of sulphur or formaldehyd. Formaldehyd disinfection is the more modern, and probably the more efficient, method. The key-holes, window-cracks, fire-places, door apertures, and all other crevices should be tightly sealed. Articles of clothing or bedding should be spread or suspended in the room in order that the disinfection may be as thorough as possible.

The most convenient manner of formaldehyd disinfection results from the use of the generator. As commonly employed, however, the formaldehyd is sprinkled upon a sheet and suspended upon a clothes-line. There should be used one pint of formaldehyd to every 1000 cubic feet of air, and the room tightly closed for at least twelve hours in order to make fumigation as thorough as possible. Much of the clothing, bedding, and sometimes the rugs may be disinfected by placing in a steam sterilizer. If sulphur is used, it should be placed in an iron vessel, which in turn is put into a tub partly filled with water. The iron kettle should stand upon bricks placed in the bottom of the tub. About three pounds of powdered sulphur should be used for every 1000 cubic feet of air. After the sulphur has been ignited, the room should be tightly closed, and remain unopened for from ten to twelve hours. If sulphur candles are employed, there is considerable danger that the disinfection will be incomplete unless several candles are burned at the same time in a small room. The walls, window-frames, and other wooden portions of the room should be thoroughly washed with the disinfecting solution previously described.

Further considerations relating to the care of the consumptive, the hygiene of the room, and the importance of detailed instructions in the interests of the *invalid* will be discussed in connection with the following subdivision.

CHAPTER LXXXV

THE EXTENSION OF MATERIAL AID ACCORDING TO THE VARYING NEEDS AND REQUIREMENTS OF DIFFERING CLASSES

An organized effort toward the suppression of consumption, to be effective, must take cognizance of the obligation imposed upon society to render, when needed, substantial assistance to sufferers from the disease. The movement for the restriction of tuberculosis must not be permitted to assume the characteristics of a "crusade" against the individual consumptive, but rather against the conditions which make possible the existence of the scourge. There must be a campaign against *tuberculosis* rather than the *tuberculous*. Both for the attainment of the best results in prophylaxis and for humanitarian reasons the attitude of society, as directed largely by the medical profession, must not partake of oppression and persecution. Arbitrary measures are demanded only by the exigencies of unusual cases. Upon the other hand, the predominating spirit actuating all attempts of administrative control should be that of benignancy, supervisory helpfulness, and material aid.

The first appeal for assistance arises from the great mass of needy consumptives who are confined to their homes. To such a class, instructions as to the *sanitary disposal* of sputum and the *hygiene of the room* are of but slight value unless means are provided to permit their proper execution. In other words, practical aid to the ignorant and impoverished constitute an essential factor in the general scheme of supervision surely no less important than the distribution of educational leaflets and the periodic visits of nurses and inspectresses. The benefits derived as a result of the visiting nurses' association and similar organizations, though manifold, can be greatly augmented by the disbursement, under their direction, of sputum-cups, gauze, disinfectants, or other material used for the purposes of prevention. The cost is utterly insignificant in comparison with the results to be obtained, and the same is true of the expense necessary to supply deficiencies in the way of food or clothing in individual cases. At least fresh eggs and milk should be freely furnished to the very poor. By this means not only are there afforded additional opportunities for the restoration of working power and subsequent maintenance of families, but also greater assurances of compliance with precautionary rules. Among the destitute the probability of faithful coöperation on the part of invalid or family is much enhanced if there are sustained relations of mutual reciprocity. The advanced consumptive who, in ignorance and poverty, is destined to succumb to prolonged illness at *home* represents by all odds the *greatest source of danger* as regards the transmission of the disease to others. Assuredly no investment can yield a more substantial return than the extension of material aid to such a class, in the hope of thereby diminishing the possibilities of contagion.

Assistance to these people should also include the distribution of needful articles of clothing and such medicines as are demanded under the sanction of the visiting nurse or other official representatives. Provision should be made for the proper cleansing of rooms and cloth-

ing, the cost of frequent scrubbings of the floor and washing of the linen being defrayed at public expense.

Not the least important province of the nurse or inspectress in the interest of the patient is a supervision of the immediate environment. Although often a matter of tedious detail, the advantages of a proper attention to the surroundings are almost incalculable. An intelligent and resourceful inspection of apartments often affords means for an out-of-door existence which would at first be considered as impossible of attainment. Recourse may be taken to back porches, roofs of tenement houses, tents, and improvised aëraria, by means of which simple contrivances the invalid is permitted to partake of the benefits of fresh air and sunshine. If the patient is unable to stay out-of-doors, the mere supervision of the sick-room is sometimes fraught with important benefits. The selection of a room containing the greatest facilities for ventilation, and with a sunny exposure, falls entirely within the scope of visiting supervision, as does even the arrangement of the furniture, the situation of the bed near an open window, the adjustment of temperature, and the regulation of the amount and character of bed-covering. Attention to the foregoing considerations involves but slight expense, while a devotion to detail adds immeasurably to the material comfort of the sufferer and insures, as a rule, conformity to precautionary instructions. An important advantage of systematic periodic visitation is the opportunity permitted to acquire accurate data as to the sanitary conditions and the probable dangers of infection to others. Upon this evidence may be based any action leading to the forcible removal of the patient to special institutions.

INSTITUTIONS FOR CONSUMPTIVES

From the aspect of *prophylaxis*, institutional care and supervision are demanded by three fairly distinct classes of pulmonary invalids:

(*a*) The hopelessly ill and impoverished.

(*b*) The vicious, who refuse to conform to established rules.

(*c*) The consumptive poor, who, with suitable assistance, offer a reasonable prospect of recovery.

No inclusion is made of the non-indigent incipient class, for whom especially sanatorium provision has been provided. Without the slightest reflection upon the usefulness of institutions open only to patients with slight infection and in comfortable circumstances, the fact remains that from the standpoint of *prevention* such patients do not comprise a group constituting important elements of danger to others. The construction of sanatoria for incipient non-charity cases in the interests of prophylaxis does not represent a legitimate obligation upon society. The proper scope of such institutions will not be considered at this time, but will be reserved for later discussion in connection with Treatment.

The Hopelessly Ill and Impoverished.—For the very advanced cases, it is clearly incumbent upon society to provide segregation hospitals where the last comforts of life can be administered without the slightest danger to families or the community, and where death may be robbed of a portion of its horrors through judicious nursing and medical care. The destitute and dying consumptive who is not granted a welcome in municipal hospitals open to other classes of suffering

humanity, and is even *denied admission* to special sanatoria, is entitled, upon humanitarian grounds, to receive from the Commonwealth institutional aid when needed. In turn, society has the right, at the discretion of the health officers, to *insist* upon the *forcible* removal of hopeless cases to such institutions when sanitary precautions are wantonly or unavoidably disregarded. All municipalities should provide adequate facilities for the housing and care of these indigent advanced cases under the supervision of the health departments. In the campaign of prevention the great usefulness of institutions of this character must be appreciated by those who have become at all familiar with the deplorable conditions existing in large cities. The number of patients properly falling within the scope of hospitals for advanced and impoverished cases is legion. But little provision has thus far been made for such unfortunates, as sanatoria possessing facilities for their care are exceedingly few. From an institutional standpoint these invalids are undesirable because of the nature of their physical infirmity, and by virtue of their ignorance, destitution, and obstinacy. It is probable that many would object strenuously to detention in special institutions, and very likely would refuse to conform to established rules, and it is precisely for such consumptives that some form of sanatorium provision is demanded. It is not merely the hopeless indigent invalid who remains at home, a constant menace to the immediate family and associates, whom it is desired to remove to special hospitals, but also the great army of *homeless, roving, shiftless, intemperate, and unruly* consumptives who are notoriously negligent regarding sanitary instructions.

The Vicious Who Refuse to Conform to Established Rules.—This, of all classes, undoubtedly represents by far the greatest danger to society on account of the wide-spread distribution of bacilli resulting from reckless expectoration. The cases comprising this group of vicious, dissipated, or unmanageable consumptives are radically different from those embraced in the preceding class. The thought is, therefore, suggested that there may properly be displayed a corresponding difference in the character of the sanatoria prepared for these two classes of indigent invalids. While unnecessary multiplication of institutions must be avoided, it is, indeed, a reflection upon modern civilization to crowd these two groups indiscriminately in poorly ventilated and sometimes loathsome poorhouses.

Adequate accommodations should be provided for worthy advanced consumptives without an enforced intimate association with the vicious and dissipated. The hospital for advanced cases should, indeed, be a *refuge* in literal compliance with the spirit of the German institutions, *i. e.*, "Friedensheim," or "Home of Peace."

It is apparent that, in the interests of humanity, *separate* provision should be made for those less entitled to sympathetic consideration. Neither does it appear that the common jail is quite the appropriate place even for those who infringe upon the rights of society. Although admittedly violators of the law and entitled for this reason to no more consideration than other criminals, the fact remains that they do not come under precisely the *same category* and, therefore, should not be given a similar penalty. It is apparent that the punishment to be allotted to offenders against criminal law, even if tuberculous, should bear no relation to their physical infirmity. It is equally true that wilful infringement of sanitary laws by consumptives cannot justify,

even in the interests of prevention, the imposition of an *indefinitely prolonged* jail sentence.

Experience has shown that tuberculosis is already frequent among those incarcerated for other crimes in penal institutions. It would, indeed, be a short-sighted policy to crowd jails, reformatories, and prisons with unruly consumptives. In such an event it is difficult to conceive in what manner either the purposes of justice or the cause of prevention could be effectually subserved. The vast number of such individuals would preclude their proper housing under *State* supervision. The responsibility for their management and control should be assumed by the *local* communities burdened by their presence, as provision can be made with but comparatively slight expense for their proper housing. It is not insisted that a necessity exists for the construction of special detention institutions for these patients, but it is contended that *separate provision* for their reception should be made either upon the county farms, or in special wards in existing hospitals for advanced cases.

It is perfectly feasible to construct suitable accommodations upon the town farm for the care of worthy hopeless consumptives, as well as for the vicious and unmanageable. Appropriate wards or camps may be set aside to comply with the separate needs and requirements of each class. Such institutions, if conducted under the supervision of local health authorities, would aid greatly in the accomplishment of practical prophylactic results. All communities should be compelled to extend aid of this character to the hopeless impoverished consumptive and exact in return strict compliance with the law on the part of others.

The Consumptive Poor Who, With Proper Assistance, Offer Reasonable Prospects of Recovery.—Many of the people included in this group, as a result of substantial assistance, can resume their former positions as wage-earners. As a rule, they are unable in their ordinary environment to observe precautionary rules, and hence become with advancing infection a distinct menace to the community. There can be no question, therefore, as to the obligation devolving upon society to care for its *non-hopeless* indigent consumptives. The economic feature of the problem has been considered. The responsibility devolving upon the Commonwealth can be discharged only by the erection of State sanatoria or convalescent farms for those whose condition requires institutional régime, and by the construction of free tuberculosis dispensaries in thickly settled communities for the ambulant cases.

STATE SANATORIA

The maintenance of State sanatoria for partly indigent incipient cases has been amply justified by the results thus far accomplished in several localities, in which the experiment has been tried, notably in Massachusetts. In emulation of the example set at Rutland, the pendulum of public opinion is swinging strongly toward the erection of such institutions. Neither the charitable features nor the economic utility of sanatoria of this kind are subject to doubt even among the most skeptical. There is room, however, for honest differences of opinion as to the jurisdiction under which they should be operated, the manner of construction, location, the extent of industrial opportunities offered, and the character of the management. From a practical stand-

point it matters little whether these institutions are supported by State aid or by local public or private benevolence, provided the *true spirit ostensibly inspiring their construction is conscientiously maintained* by those in charge. This, unfortunately, is not always the case in public institutions on account of the pernicious influence of politics.

The selection of the site is sometimes grossly inappropriate and unnecessarily expensive. Buildings ill adapted for the purpose are occasionally erected through the advice of partizan architects. Grossly incompetent medical superintendents may be selected as a result of political favor. There may result, therefore, a great diminution in the actual usefulness of institutions, endowed with almost infinite possibilities in the way of service to others.

The essential considerations are that these buildings should be properly located, so designed and constructed as to afford suitable accommodations to the greatest number at a nominal expense, and conducted in accordance with broadly humanitarian instincts as well as along scientific lines. To this end it is obvious that the best results can be secured only through the *active coöperation of representative medical men.* It is quite impracticable to expect from a Committee of the Legislature, rendering allegiance primarily to some political ring, the elaboration of modern well-sustained ideas concerning the construction and maintenance of sanatoria. Upon such a subject there must be brought to bear the enlightenment and experience of those especially engaged in medical and sociologic work. The responsibility for the erection and supervision of such institutions should be delegated to members of the medical profession interested in the elucidation of problems of this nature. Through the coöperation of State and county medical societies, associations for the study and prevention of tuberculosis, the various charity organizations, and the local health authorities, the direction of these institutions may be consigned to individuals who are perfectly competent to discharge satisfactorily the imposed trust. It is probable that the practical efficiency of sanatoria designed for this purpose would be greatly increased if they were erected in various communities throughout the State, supported in the main by local subscriptions, yet receiving substantial aid from the State. Irrespective of the amount of assistance rendered by private benevolence, it is undoubtedly true that more satisfying results would accrue from the distribution of several institutions of this nature in different localities, than from the erection of a single imposing structure for indigent consumptives. It goes without saying that a single building of this description, no matter of what size, must be entirely inadequate to supply the pressing needs of the many unfortunate sufferers scattered throughout a State. It is also true, in spite of the insufficient accommodations, that but little stimulus would be given to the extension of further aid either through local pride or private philanthropy. The logical solution rests with the creation of so advanced a public sentiment as will inspire the construction of numerous abodes of this character for early consumptives who have not the means of self-support.

It is to be regretted also that buildings erected entirely through private generosity, though of beautiful architectural design and magnificent in proportions, are often ill suited to the needs and requirements of the comparatively small number of indigent consumptives who chance to be admitted within their walls. Meanwhile the expense

incident to these monumental structures is entirely out of proportion to the practical benefits to be secured.

The question of affording *industrial facilities* to the inmates of State sanatoria is very properly subject to some comment. As furnishing a means of diversion to those not likely to be injured by such pursuits, there is undoubtedly much to recommend the performance of *light out-of-door work*, either in the fields or garden, and of handiwork of various kinds while at *rest* upon the *porches*. Indoor employment should be deprecated under all circumstances. Many of the *arts* and *crafts*, even if practised in sunny, well-ventilated apartments, exercise a *distinctly deleterious effect* on account of the confinement, physical effort, and inhalation of dust. Upon the other hand, work in the fields, garden, or at the wood-pile is often attended by unfortunate consequences. Compulsory employment of this kind is not likely to be received with the utmost enthusiasm even by individuals participating in the bounties of State or private philanthropy.

The provision for industrial pursuits may not be expected to furnish financial assistance to public or private institutions of this character. As a source of income, pure and simple, any scheme of organized work is *not to be recommended*, as the industrial features cannot be expected to yield a financial return at all commensurate with the expenditure. Carefully selected patients may be permitted to perform such light work upon the premises for brief periods of time, as their physical condition will justify, but any organized effort toward increasing the income through the labor of patients is utter folly. Assuredly one of the important objects of such institutions will be defeated, unless the inmates are constantly subjected to the closest surveillance in order to *forestall the possibility of overexertion*.

The Influence of State Sanatoria upon Neighboring Communities and Surrounding Property.—It is important to call attention to these features connected with the erection of hospitals for advanced cases, concerning which there has been considerable popular misapprehension. The impression has become somewhat prevalent that residents of smaller towns, in which have been situated sanatoria for consumptives, have been subject to more or less danger of contagion from the influx of imported cases.

In the consideration of the possible danger of infection from visiting tuberculous invalids, it is well to discriminate clearly between the influence of so-called *closed* sanatoria, and that of *open resorts* for consumptives. The evidence thus far presented is quite overwhelming to the effect, that the closed institutions are everywhere responsible for a material *diminution* in the tuberculosis mortality rate among the neighboring inhabitants. This is explained by the pronounced educational influence exerted throughout the community by lessons in hygienic living, and the precautionary measures taught through the force of actual example. The development of tuberculosis among physicians, nurses, and attendants in institutions for consumptives is known to be exceptionally rare, in spite of prolonged intimate association with invalids in advanced stages of the disease. Upon the acceptance of these facts, it is difficult to conceive how the resident population of towns in which such institutions are located, are especially liable to infection, the exposure being practically nil and the measures of prevention being thoroughly understood. As a matter of fact, the

existence of well-conducted tuberculosis hospitals in any community must serve as an added element of protection to the public rather than as a menace.

As regards the open resorts, where, on account of climatic advantages, pulmonary invalids in advanced stages of the disease flock in large numbers, there might be expected, upon purely theoretic grounds, a possible increase of the non-imported tuberculosis mortality rate. Certain towns in Europe, notably Mentone and Nice, have frequently been cited as illustrating the development of indigenous tuberculosis among the inhabitants from the importation of pulmonary invalids. The reports from these places as to the prevalence of local infection are, however, decidedly at variance. The observations of experienced clinicians in other health resorts of Europe and America are, however, singularly in accord as to the entire lack of statistical data upon which to base the assumption of an increase in the practical dangers of infection from the influx of consumptives. Communications from St. Moritz, Davos Platz, and Cairo concur in positive statements concerning the lack of evidence as to the increase of tuberculosis among the native population at any time during recent years.

In 1905 an inquiry was conducted by Dr. C. F. Gardiner as to the influence, if any, of imported pulmonary invalids upon the native tuberculosis death-rate in open resorts throughout Massachusetts, Connecticut, New York, North and South Carolina, Virginia, Georgia, Texas, New Mexico, Arizona, Utah, California, and Colorado. The result of this inquiry showed conclusively that the imported tuberculous invalid was scarcely ever a source of danger to the native population, and that the practical likelihood of such infection in open resorts was grossly exaggerated. It must be insisted, in spite of such reports, that the protection of these communities is dependent largely upon the vigilance of the health authorities and the effectiveness of their administration. Gardiner has reported that an investigation conducted by himself and other physicians in Colorado Springs, including different health officers, has disclosed, out of a population of approximately 20,000 people, but one case each year since 1889 originating among the native population, or sixteen cases in sixteen years in spite of an exceedingly large number of imported pulmonary invalids. My own observations in the city of Denver during a period of sixteen years have been reported in connection with the Geographic Distribution of Tuberculosis.

No valid objection can be presented to the erection of hospitals for tuberculous patients upon the score of fancied dangers to the community. Strenuous opposition may sometimes be interposed as to their erection, but this usually emanates from property-owners in the immediate vicinity, who assume that values will be unfavorably affected by the proximity of such institutions. This element of deterioration in the value of surrounding property, which is more imaginary than real, cannot obtain when a site is chosen either in the country or in the suburbs of the larger cities. On the other hand, it has been found that the presence of these institutions has been decidedly helpful rather than unfavorable. In almost all instances surrounding property has appreciated in value through the increase of population in localities previously isolated or abandoned. With increase of visitors there necessarily takes place expansion of business of all kinds, improvement of adjacent property, with attention to the locality as a healthful

and desirable place of resort. Prejudice and preconceived ideas as to the supposed undesirability of institutions of this kind, founded upon misconceptions of actual facts, should not be permitted to thwart the important interests either of the Commonwealth or of pulmonary invalids as a class. Considerations pertaining to the location of sanatoria, hygienic conditions, immediate surroundings, water-supply, soil, drainage, accessibility, initial expenditure, and cost of maintenance will be considered in connection with the Sanatorium Treatment of Consumption. It is submitted at this time, however, that institutions designed for indigent cases do not require an elaborate outlay for buildings, and that a suitable selection of the site, with provision for the largest possible number of inmates, is of far greater importance than the erection of imposing structures. Institutions non-charitable in character and not maintained at public expense may be, of course, as ornate and magnificent as their promoters desire.

THE TUBERCULOSIS DISPENSARY

One of the most important factors in a supervisory and educational campaign is the tuberculosis dispensary. While its province is more directly for ambulant cases than for others, its scope is surprisingly far reaching. Upon superficial inquiry it might appear that the necessity of special dispensaries for tuberculous patients does not exist, and that this feature could be safely delegated to the other free dispensaries, so common in large municipalities. This aspect of the movement toward the prevention and control of consumption has been regarded by some as subordinate to many other phases of the campaign. In truth, however, the ultimate influence of the tuberculosis dispensary is almost beyond estimation. Its usefulness is not confined merely to the rendering of routine gratuitous assistance to consumptives, but more to the opportunity afforded for personal contact with the pulmonary invalid in his home, the inspection and control of his environment, and the imparting of responsible instructions. Among the varied functions of such an institution there should be recognized its peculiar position as the central point of all other agencies engaged in the prevention of the disease. In other words, it often represents the initial step in the acquirement of data regarding centers of infection.

To R. W. Phillip, of Edinburgh, are students of preventive medicine indebted for the present conception of the unique province of the tuberculosis dispensary. Through his individual efforts there was founded, in 1887, the Victoria Dispensary for Consumption in Edinburgh, the first institution of this kind in existence. Since then similar buildings have been constructed in Belgium, France, and Germany, and a few cities of the United States. The underlying motive inspiring the founding of the Victoria Dispensary by private charitable enterprise was not so much the care of patients applying for treatment nor the possible amelioration or cure of the disease. It was hoped to obtain a more ready access to centers of infection in families and lodging-houses, in order that a more comprehensive supervision of infected dwellings might prevail and the general scheme of prophylaxis become more effective.

In Scotland, unlike other countries, the tuberculosis dispensary antedated the erection of sanatoria, and has remained not merely an isolated

feature of the tuberculosis movement, but has gradually developed into the most important integral part of the entire system of organized effort. It should be, in fact, a clearing-house for all indigent consumptives, from which, after thorough examination of the physical conditions and environment, they may be sent, when necessary, to appropriate institutions. The province of the tuberculosis dispensary as a sort of general bureau of information may be subdivided for the following purposes:

1. Invitation of indigent tuberculous patients and those presenting suspicious evidence of the disease.

2. Thorough physical examination of all comers, with bacteriologic analysis of the sputum and the preservation of a detailed record of the family history, previous history, present illness, occupation, residence, and environment. In this manner there is obtained an accurate *diagnosis* of the condition, the early recognition of the disease representing one of the most important elements in the war of prevention.

3. Facilities offered for the imparting of competent instructions to patients, and for the inspection of dwellings and workshops. In addition to personal advice and exhortation to obey instructions, circular information may be distributed in various languages, as previously described.

4. Opportunity for the inclusion of the case in a list of those to be observed continuously by the visiting nurses' association or similar organizations.

5. Discrimination permitted between patients who are best suited for residence in institutions for incipient cases, detention resorts, or hospitals for hopeless consumptives. The proper classification of these individuals and the recognition of their peculiar needs and requirements represents one of the important functions of the dispensary.

6. The extension of material aid, when necessary, in the way of gratuitous advice, food, clothing, medicines, sputum-cups, gauze, disinfectants, etc., in accordance with the manner outlined for the consumptive at home.

7. The offering of comfort, reassurance, and general guidance to immediate relatives and friends upon matters pertaining to the general subject of prevention. Under this heading should be included, when suggested by the visiting nurses, the examination, by some member of the dispensary medical staff, of any member of the family or others with whom the patient has been brought into intimate association.

In general, the primary function of the tuberculosis dispensary is its position as a basis for further operations. Without this the house-to-house visitation, with supervision of the consumptive at home, is entirely impracticable in cities devoid of compulsory notification laws. Further, the proper selection of cases for the various institutions for consumption would be quite impossible without the preliminary direction exercised at the dispensary.

A valuable modification of the tuberculosis free dispensary is found in the so-called *day resort* or *day cure*. In 1900 a plan was adopted in Berlin for the establishment of day resorts for convalescents from various hospitals, of which tuberculous patients comprised approximately one-half. Accommodations were secured in a large open place, and facilities afforded for patients to recline in the open air during pleasant weather. They were permitted to converse and play games during a portion of the day, but were compelled to rest at other times. They were also instructed with care as to the danger of transmitting the disease to

others. Food was served several times during the day. This system of "day cures" has been adopted in Germany, France, England, Belgium, and Austria, and remarkable results are being achieved. A similar establishment has been started in Roxbury, Mass., known as "The Parker Hill Sanatorium." Here invalids are offered the benefit of pure air, good food, and such medicine as is needed. They are afforded an opportunity to rest in reclining chairs or cots, and are comfortably clothed and housed during inclement weather. Similar facilities are offered to women in Boston at the Samaritan Hospital Day Camp.

Valuable as is this modification of the free dispensary, the effectiveness of such a scheme must be very greatly curtailed unless there be instituted a system of *domiciliary visitation*, precisely after the manner of the tuberculosis dispensary. It is this latter feature of reaching the homes, where grossly unsanitary conditions are found to exist, that is productive of the best results in the effort toward prevention. The greatest degree of protection to the public must accrue from the daily personal dissemination of practical truths in the very homes and workshops of the poor, where exists the most important habitat of the disease. In view of the fact that indigent consumptives are out of all proportion to the capacity of any number of institutions, it is apparent that the tuberculosis movement should relate not alone to providing a temporary means of lodging for the known victims of disease, but to conducting a definite system of defense. Through the influence of kindly personal contact resulting from periodic domiciliary visits, the propagation of knowledge regarding the dangers of infection becomes particularly effective. It must be remembered that it is this educational influence within a community that reflects one of the chief benefits of all consumptive institutions or agencies. Those who have profited, either at home or in sanatoria, through the force of example readily become, in turn, self-constituted apostles to spread broadcast the gospel to which they have become so much indebted. With a correct appreciation of the proper methods of hygienic living, the consumptive is enabled in a practical way to enlighten those with whom he may come in contact, concerning the manner of restricting the transmission of the disease.

Still another modification of the tuberculosis free dispensary, known as *The Tuberculosis Class System*, originating with Dr. Pratt, and perfected by the assistance of Dr. Hawes, 2d, of Boston, has been established. It has been the effort further to elaborate the educational feature and supplement the deficiency in supervision and discipline which necessarily obtains where the dispensary methods alone prevail. This system is designed to reach but comparatively few people, but to extend to those the maximum attention. The patient is admonished to lead a strictly out-of-door life, avoid work, and to comply rigidly with detailed instructions. The clinical history is taken, and the lungs and sputum periodically examined. Visits to the home are made by nurses or "friendly visitors," so called, definitely qualified to impart kindly words of advice and yet to exact obedience. Facilities are found, if possible, for sleeping out-of-doors, either upon a balcony or upon the roof, protected by awnings, or in tents upon the ground. Reclining chairs are provided and needed assistance rendered in the way of food and clothing, after the manner inaugurated under the auspices of charity organizations and visiting nurse associations in different cities.

Similar work may be accomplished in the suburbs of large cities,

as is practised under the supervision of the Social Service Bureau of the Massachusetts General Hospital. Suburban tuberculosis classes are formed to provide for out-of-town consumptives. While the percentage of cures has thus far been very small, the primary object, namely, the education of the patient, has been accomplished in nearly all cases. An element of some importance in the conduction of suburban classes is the greater probability of arousing a local interest among the suburban health authorities. An active initiative among these officials to care for their own consumptives is a result fondly to be desired. The class system, though worthy of much commendation, appears, on account of the elaborate detail, to be very limited in its application. It would almost seem, in the present state of public apathy and indifference in some quarters, with the tendency toward hysteric phthisiophobia in others, that more practical results along the lines of prevention could be secured by not concentrating the energies of intelligent workers upon so comparatively few patients. It is probable, in the interests of prophylaxis alone, that the sphere of usefulness of the class system in some instances could be extended by dispensing with the weekly meetings after a short period, and thereby increasing the list of members or by the formation of new classes from time to time.

CHAPTER LXXXVI

THE DISSEMINATION, TO THE GENERAL PUBLIC, THROUGH THE MEDIUM OF VARIOUS CHANNELS, OF AUTHENTIC OFFICIAL INFORMATION REGARDING THE PREVENTION OF CONSUMPTION

Emphasis has been given to the prime necessity of imparting immediate instruction to the pulmonary invalid, and of appealing in devious ways to his sense of obligation, that the rights of others may be respected. In the effort to restrict a preventable disease that destroys annually 150,000 lives in this country, especial importance also attaches to the education of the *general public*. The ignorance, apathy, and indifference for a long time exhibited regarding a subject worthy of the utmost concern, and the popular prejudice later entertained, jointly suggest the need of a comprehensive system of education directed to all classes and conditions. Above all, there is demanded an acceptance of rational, well-sustained conceptions relative to the possibilities of infection, and the best means of avoidance. To divest the public mind of exaggerated and distorted notions regarding certain supposed elements of danger, is no less desirable than to enlighten the masses regarding proper methods of defense against conditions actually inimical to health.

The education of the public concerning a problem of such overwhelming importance can be secured only by the wide-spread inculcation of practical knowledge and the convincing demonstration of actual facts. By whatever methods popular instruction is attempted, it is quite essential that, for real effectiveness, there should be instituted a *systematic* propaganda of education. Unity of purpose and harmony of action are

important considerations, and to this end it is suggested that all local effort should receive its general direction and impetus from some duly recognized and responsible source. The vital element of success in the educational movement relates to the establishment of the most complete confidence on the part of the people in the ability, sincerity, and executive capacity of those upon whom is imposed the task of official guidance.

There is, perhaps, no better medium for the dissemination of authentic data concerning consumption than the formation of local antituberculosis societies, acting in full unison with municipal and State health authorities, and in coöperation with a central organization of national scope. In this manner the truths to be carried home to each individual will be in accord with the most modern scientific investigation, and will reflect upon practical questions the consensus judgment of active, trained workers, whose lives have been devoted to the study of medical and sociologic conditions. Practical instruction emanating from such sources, and resourcefully conveyed to the general public through various channels, cannot fail to have a most enlightening influence.

Local organizations, either charitable in character or operating purely in conjunction with the National Association for the Study and Prevention of Tuberculosis, constitute, if efficiently officered and properly equipped, the most effective agencies under whose auspices may be transmitted trustworthy data for the information of the public. It should be borne in mind that the educational aim to be accomplished is attained, not wholly as a result of the organization employed for this purpose, but rather by virtue of the aggressive initiative, tactfulness, and enthusiastic devotion to duty of the executive officers. In this connection it is not inappropriate to pay a tribute to the indomitable energy of those who have so cheerfully and capably discharged their official obligations during the present national agitation regarding consumption.

Other things being equal, the most satisfactory efforts in the way of public enlightenment may be expected to attend a plan of campaign formulated along the lines of a national association with subordinate State organizations. Such a situation prevails in the majority of the States, organized work being carried on in close coöperation with the National Association founded in 1904. It is well worthy of comment that in several States, associations for the prevention and control of tuberculosis were actively in operation long before the National Association was contemplated. The first State organization of this character was the Pennsylvania Society for the Prevention of Tuberculosis, which came into existence in 1892. Since then numerous State associations have been formed, as well as other organizations for the control of the disease. The National Association for the Study and Prevention of Tuberculosis received its inspiration in 1904, and its inception for organized effort at Atlantic City in June of the same year. The first annual meeting was held at Washington in May, 1905, the work being divided into three sections, *i. e.*, the sociologic, clinical and climatologic, pathologic and bacteriologic. It has been the effort of this body to maintain such an organization as to combine the more or less divergent efforts of other associations and of individual workers in order to conduct, by dint of united coöperation, a far-reaching campaign of

education. Under the capable direction of the executive secretary, Mr. Livingston Farrand, the practical work of the association has been one of signal achievement. State associations now exist in the following States: New Hampshire, Vermont, Pennsylvania, New Jersey, Delaware, Maryland, North Carolina, Georgia, Ohio, Indiana, Kentucky, Illinois, Minnesota, Iowa, and Washington. Of these, eight have been organized during the past two years; *i. e.*, New Jersey, Delaware, North Carolina, Georgia, Kentucky, Minnesota, Iowa, and Washington. According to the report of the executive secretary, definite plans are completed for organization of State associations in Missouri, Rhode Island, Wisconsin, and New York. The movement for organization is well under way in Virginia, Michigan, California, Alabama, Texas, North Dakota, and Oregon. In Massachusetts excellent work is being conducted under the auspices of the Boston association, which acts as a center of operation for the entire State.

Largely through the efforts of the National Association an impetus has been given for organized effort not only in the larger cities of the country, but in many of the smaller communities. Of the thirty-eight cities in the United States with a population of over 100,000, according to the census of 1900, there existed, two years ago, definite organizations for the prevention of consumption in but fifteen, *i. e.*, New York, Chicago, Philadelphia, St. Louis, Boston, Baltimore, Cleveland, Buffalo, Detroit, Washington, Minneapolis, Rochester, Worcester, New Haven, and Scranton. Since the organization of the society, effective associations for the prevention of the disease have been formed in Cincinnati, Pittsburgh, New Orleans, Newark, Jersey City, Louisville, Providence, Columbus, Syracuse, Milwaukee, and Patterson. Twelve cities out of the thirty-eight have thus far failed to complete definite organizations for work along these lines, although steps are now being taken for this purpose in St. Paul, Toledo, Los Angeles, and Fall River. The movement for the formation of antituberculosis societies is being agitated in Indianapolis, Denver, and Allegheny. Effective work, however, has been accomplished in Denver for some years by the Medical Advisory Committee of the Charity Organization Society. Up to this time, San Francisco, Kansas City, St. Joseph, Omaha, and Memphis are reported to be without effective organizations for the prevention of tuberculosis. In forty of the smaller communities throughout the country a spirited effort has been made for the prevention of consumption, thus establishing a total number of seventy-two local organizations in correspondence with the National Association. The movement for organizations is now being agitated in many other of the smaller cities.

An active aggressive campaign is being carried on in Porto Rico upon the lines recommended by the National Association. Organized work in the form of antituberculosis societies has been carried on effectually in other countries. In Great Britain the work is performed systematically under the guidance of the "National Association for the Prevention of Consumption and Other Forms of Tuberculosis," with auxiliary branches in various parts of the United Kingdom. In Germany there are in the larger cities over 120 societies whose avowed purpose is to combat tuberculosis. These associations are closely identified with a central committee for the establishment of sanatoria, and are the means of stimulating powerfully the movement toward prevention. In France about 80 associations exist in various

portions of the Republic, all operating in unison with the Central Federation, which enjoys the aid and patronage of the highest civic officials, and the coöperative support of all medical workers. In Switzerland the organized movement has been systematically conducted since 1895. There are antituberculosis societies in 17 cantons, all established for the purpose of disseminating popular education. A central tuberculosis association was founded in 1902. In Denmark the campaign of prevention originated in 1895 among the members of the Danish Medical Association. While active efforts were made toward the education of the masses and much valuable work accomplished, the "National Association for Combating Tuberculosis" was not founded until 1901, since which time great exertions have been made toward the enlightenment and protection of the people. Organized movements are being conducted with enthusiasm in Italy, Norway, Sweden, Austria, Spain, Scotland, Russia, Portugal, Canada, Australia, and in several countries in South America. From the experience offered and the results obtained the world over by virtue of effective organization, it is clearly demonstrable that successful organized endeavor toward public education must proceed largely through the instrumentality of numerous local societies, in allegiance to a central association endowed with supervisory authority, and coöperating with the movement in other countries through the influence of an international association.

Under the direct and responsible direction of these associations instruction may be imparted to the people through the medium of: (*a*) The schoolroom; (*b*) publications; (*c*) the lecture platform; (*d*) exhibitions; (*e*) the family physician.

The Public Schools.—A comprehensive scheme for the education of the public should have for its foundation the teaching of the elementary principles of hygiene to the very young. There are many obvious difficulties in the way of awakening adults to a realizing sense of the enormity of the tuberculosis problem. It is comparatively easy, however, to attract the attention of children in simple and ingenious ways, thus not only beginning their prophylactic education at an early age, but perhaps, more important still, conveying information through them in a peculiarly effective manner to their parents. Once the interest having been thoroughly aroused in the schoolroom by the use of drawings, colored illustrations, elementary text-books, and entertaining talks, the child is wont to carry home a wondrous recital of the hygienic lesson. The attention of the family thus irresistibly attracted to a subject replete with human interest, is further stimulated by the receipt of supplementary circular information, which each child should be instructed to deliver to the parents.

It is essential that the instruction received at school should be compulsory, and that it should be imparted under the supervision and with the indorsement of duly constituted medical and educational authorities. Text-books and educational pamphlets should be prepared with the utmost care, especial effort being made to insure simplicity of style and attractiveness of presentation. These considerations apply with equal force to oral methods of instruction, the prime desideratum being an intelligent understanding of a few elementary principles, rather than the effort to memorize a tedious list of precautionary rules. The instruction in schools should be undertaken at first by medical men of especial fitness and adaptability, but the work may later be dele-

gated to teachers previously trained in hygienic science. The mere perusal of illustrated text-books, no matter how attractive in design, is quite insufficient for the satisfactory elaboration of fundamental propositions in connection with consumption. It is desirable that all abstract statements be properly interpreted and fully expounded in their practical application by competent instructors.

The efforts of children in the warfare against consumption may be enlisted actively or not at all, according to the manner of their instruction. The distribution of leaflets and the learning by rote of printed matter containing certain negative pronunciamentos are far less effective as a measure of prophylaxis and education than verbal admonitions. The submission to school-children of a long list of printed rules to be committed to memory in the hope of their actual observance is not inspired by a realizing sense either of the practical sources of danger or of the most effective means to secure the coöperation of the young. No disparagement is intended of the excellent instructions given to children in the interests of personal cleanliness, nor of their transmission in printed form to adults. It is contended simply that children should live as children, and not until they become of more mature age should they be expected to put away the inherent ways of childhood and become amenable to the influence of printed regulations. When it shall be brought to pass that little ones have become so impregnated with the spirit of prevention as, in conformity with printed rules, to refrain from spitting upon playgrounds, but only upon bits of cheese-cloth to be placed in a suitable repository before being burned, to wash their fruit before eating it, to give up whistles, trumpets, bean-blowers, apple-cores, to wash their hands and clean their nails before putting food in their mouths, and to resort solely to individual drinking-cups at school, then, indeed, will the millenium of prophylaxis be reached. While not the slightest abatement of rational methods in the education of the young should be countenanced, it is believed that the more practical results of instruction imparted in the schoolroom will be exhibited in the transmission of this knowledge to the home, and its subsequent application to the prevention of house infection. It is not likely that the curtailment of the disease will be effected, to a material extent, through the development of radical innovations pertaining to the instinctive personal habits of children.

Publications.—A most important feature of a systematic educational propaganda consists of the wide-spread dissemination of authentic printed information, issued in various forms under the sanction and authority of antituberculosis societies or other equally responsible sources. The information for the general public should be essentially reassuring, if not optimistic in character, though by no means minimizing the known dangers of infection under unfavorable conditions. In view of the frequent unreasoning fear and the somewhat intolerant public sentiment relative to contact with pulmonary invalids, it is particularly desirable that association with conscientious and cleanly consumptives should be emphasized as entirely innocuous, and that contact with the careless or vicious, indicated as the chief source of danger. It should be made perfectly clear that the campaign of prevention relates to the disease itself and the conditions responsible for its development, rather than to the unfortunate people suffering from the tuberculous infection.

The detailed information with which the public should be supplied through various channels will be presently reviewed, but of more immediate interest is a consideration of the most *effective manner* in which to distribute the *educational literature*. It is readily apparent that recourse should be taken to all available avenues of reaching the public eye—circular distribution, reprints, magazine articles, and newspapers. It is also evident that an effort should be made to bring suitable reading matter of this nature before all classes and nationalities. The subject material and the form of presentation must needs vary within wide limits in accordance with the intelligence and sphere of life of those to whom the literature is addressed.

While much of value has been accomplished as a result of the circulars issued from time to time by various health authorities and antituberculosis societies, the fact remains that the field has been insufficiently canvassed. Some of the current popular magazines have contained valuable articles written by laymen offering suggestions in the way of prevention or treatment. Other periodicals have been greatly enhanced in usefulness by able contributions from physicians endowed with a sense of sociologic obligations. The great mass of the people, however, have not been enabled to profit to the fullest extent from the modern attitude of the profession regarding the possibilities of prevention. Ethical scruples have been entertained by medical men as a class against permitting their publications to appear in other than strictly professional journals, and the public, to a large extent, has been denied the privilege of perusing the contributions and discussions of learned observers upon practical questions. As a result, numerous articles of absorbing human interest are buried in the public transactions of medical societies or submitted through the agency of medical journals only to the inspection of members of the profession. Popular monthly magazines, current weeklies, and daily newspapers, all of which would eagerly grasp at authentic reading matter bearing upon the subject of the hour, are not permitted, through the innate modesty of the profession, to fill their columns with educational data compiled by medical men of recognized eminence. If it is really important to convey reliable and complete information to the masses regarding the communicability of consumption and the methods to prevent its spread, there can be no excuse for failure to utilize, under the jurisdiction of antituberculosis societies, the *public press*, no matter in other respects how sensational may be its tone, insincere its motives, or superficial its character. Articles printed under the sanction and at the request of regularly constituted executive officers of tuberculosis committees and antituberculosis organizations, need not reflect in the slightest upon the ideals of the contributors. It is important that such articles be made a conspicuous feature and appear at periodic intervals. They should be written entirely by individuals especially fitted for this work, to which they have been assigned by responsible officials in the organized campaign of education.

To those interested in the more scientific aspects of the tuberculosis problem, opportunity should be afforded for securing copies of the transactions of the National or State associations for the prevention of the disease. There should be published occasionally, in the popular magazines, or newspapers, a list of the more recent or important contributions upon technical phases of the subject, and information given

as to where and how reprints may be obtained. These should be provided through the instrumentality of antituberculosis societies at a nominal cost. The public should be solicited to subscribe for the official organ of the National Association for the Prevention of Consumption, "Outdoor Life," which in turn should devote its columns almost exclusively to the education of the people upon practical problems pertaining to the control and suppression of the disease.

Effort should be made to enlist the coöperation of publications upholding the cause of labor, in order that the institution of rational measures to restrict the development of consumption among the masses, rather than a strife for shorter hours, be made the bone of contention of trades unions. The same is true of the many journals devoted to the interests of the numerous secret and fraternal organizations, the watchwords of cleanliness, protection, and disinfection being much more appropriate, from a practical standpoint, than faith, love, hope, charity, etc.

Lectures.—Generally speaking, more difficulty must be experienced in reaching the public through the lecture platform than from the public press. Further, the number of individuals influenced directly through this means is necessarily small. The great mass of the people are not sufficiently awake to the gravity of the situation to feel particularly attracted by the anticipation of an evening devoted to the elucidation of tuberculosis problems, no matter how ably or ingeniously the subject is presented. The several organizations under whose auspices lectures may be given are capable, as a rule, of securing but a comparatively small attendance, and this composed of individuals already interested more or less in sociologic matters. The audiences are composed mostly of members of women's clubs, young men's Christian associations, churches, fraternal organizations, and of school-teachers' societies. The very class whom it is most essential to attract to such gatherings, *i. e.*, the working people, the wage-earners, operatives, occupants of tenement houses and of unhygienic apartments, are rarely present. It follows that, for practical far-reaching purposes, the beneficent educational influence of such lectures may be obtained more from their *publication in full* with the accompanying *editorial comment* than from the discourse itself.

To be particularly effective, lectures must be given in serial form at rather short intervals, and embodying different phases of the tuberculosis question, and adapted to audiences of varying character. They should be suitably illustrated by drawings or stereoptical pictures, and the subject matter interspersed with pertinent or amusing anecdotes to furnish a justifiable degree of entertainment, and maintain a lively interest in the more important details. Lecturers in every way qualified to furnish enlightenment and entertainment are exceedingly difficult to obtain, and thus another difficulty is encountered in a successful application of this method of educational work. It should be utilized, however, in all localities, when rendered possible by the willing coöperation of earnest and competent workers.

Exhibitions.—A novel and singularly attractive manner of presenting tuberculosis truths to the general public has been found through the agency of tuberculosis exhibitions. This method, originally adopted in order to bring important data forcibly before the eye, has already carried conviction to a vast number of people. The first exhibition was held in New York under the auspices of the National Association

for the Prevention of Tuberculosis and the local committee of the New York Charity Organization Society. The communicability, preventability, and curability of consumption were demonstrated by diagrams, charts, models, photographs, pathologic specimens, and lantern slides in connection with lectures. The exhibit operated in connection with the National Association, was inaugurated November, 1905, and has proved a remarkably efficient means of promoting the education of the public. The attendance has been most gratifying, over 200,000 viewing the exhibition during the first six months of its operation to May, 1906. During the following year the attendance was 167,981, making a total of 372,000. The executive secretary reports that from June, 1906, to April, 1907, it was shown in the following eleven cities:

	Attendance
Grand Rapids, Mich.	12,000
Manistee, Mich.	3,200
Detroit, Mich.	6,400
Toronto, Canada	12,969
Cleveland, Ohio	15,000
Cincinnati, Ohio	38,000
Mexico City	3,017
San Antonio, Texas	8,000
Minneapolis, Minn.	17,225
St. Paul, Minn.	16,170
Providence, R. I.	36,000

Numerous local exhibitions are now being presented in New York, Boston, New Jersey, Illinois, Toronto, Rhode Island, Maryland, Washington, D. C., and the State of Washington, under the authority of State or local associations. From the interest already shown in these exhibitions, it cannot be questioned that they constitute a wonderfully effective means of enlightening the masses regarding the dangers of infection and the means of prevention. Their practical value is greatly enhanced by judicious advertising. In fact, it is doubtful if, without a vigorous newspaper and circular campaign, public interest could have been aroused to so gratifying a degree. Thus, in effect the exhibition combines the publication of educational literature, the delivery of lectures, simple talks to children, and the actual visual demonstration of vital data.

The Family Physician.—The personal interpretation of important educational matter constitutes one of the most essential features in the campaign against tuberculosis. In no manner can the interesting truths pertaining to the prevention of consumption be brought home to families and individuals so completely as through the agency of the attending physician. Through the influence of the spoken word and the force of personal example, the hygienic lessons are diffused through the community much more effectively than from volumes of printed matter, exhibitions, or lectures.

Notwithstanding a masterly manner of presentation of the educational data in various forms, and the convincing demonstration of the advantages and necessities of rational prophylaxis, individuals often refuse to accept the logic of facts and refer vital considerations of this nature to the family physician for a final decision. Influential results, therefore, in the warfare against the transmission of the disease, are largely dependent upon the ability and conscientious devotion of the

physician, both in the exercise of his strictly professional duties and in the sphere of social life. Were all physicians actively and intelligently enlisted in the cause of prevention, the educational warfare could be carried directly and irresistibly to all the homes and workshops which may be described as the very heart of the enemies' country. Unfortunately, the commercial aspects of medical practice are permitted in some instances to assume such prominence among busy practitioners as to stifle natural humanitarian instincts.

The proper expounding of the doctrines of prevention not infrequently falls entirely upon the attending physician, who in a few concise words, evincing a profound personal interest, may wield a tremendous influence for good among his immediate clientele. The attitude of any physician in regard to the principles and practice of preventive medicine is usually more or less familiar to the general public, particularly in the smaller towns, and the influence upon the community of his acceptance or repudiation of sanitary and hygienic measures is, indeed, far reaching. The practical effects of the present effort toward the education of the public are rendered almost nugatory in some cases through the stupidity of irresponsible physicians. A few, even when appealed to for a practical interpretation of educational data, have been known to remain so utterly indifferent to their obligations as to disclaim their value or to condemn with faint praise.

It is well known that one of the most essential requisites for a successful campaign against consumption is an early recognition of the disease. Deplorable as it may seem, the fact remains that, in a very considerable proportion of cases, the nature of the affection is not detected by the attending physician until long after active destructive change has taken place, greatly impairing the prospects of recovery and increasing many fold the dangers of conveying the infection to others. It must be admitted that in the majority of cases the *available evidence is ample to furnish an early diagnosis*, which, if made, would enhance beyond description the chance of restoration to health, and minimize the possibilities of further transmission. It is of but little avail to awaken public interest in a great educational movement, to enact laws pertaining to the administrative control of tuberculosis, to erect dispensaries, sanatoria, and hospitals, if the family physician is to continue in the making of delayed and erroneous diagnoses. It almost appears that it is not so much the public that needs to be educated concerning the sociologic features of tuberculosis, as it is the rank and file of the medical profession relative to the detection of the disease in its incipiency. Failure to appreciate the significance of rational symptoms, to conduct a thorough physical examination, to recognize the physical signs and properly interpret their import, represents one of the very greatest weaknesses in the defense now being presented against the spread of the disease. The education of the public through the family physician by word of mouth should begin with the education of the physician himself in order that he become fitted to render truly effective aid. It is undeniable that he may exert a powerful influence for good or evil in his purely professional capacity. It is the *man behind the stethoscope* who too often adds materially to the pathos of existence of pulmonary invalids and their unfortunate families. Upon the other hand, the sphere of usefulness of the enlightened and conscientious physician is almost unlimited in its application to the cause

of prevention. Upon him is bestowed the privilege of the prompt recognition of incipient tuberculosis, the detection of unhygienic conditions, the supervisory control of the invalid, the protection of the family and society, and the inculcation of just conceptions as to the communicability and preventability of the disease.

CHAPTER LXXXVII

WHAT THE PUBLIC SHOULD KNOW

In preceding pages it has been stated that the information to be conveyed to the public, while pertaining to the possibilities of infection and the importance of prevention, yet should be essentially reassuring in nature. It is quite unnecessary to add to the burden of the consumptive by increasing the humiliation already suffered by reason of popular intolerance. It is important, therefore, to remove, as far as possible, exaggerated fears relative to the dangers of infection, *provided* precautionary rules are observed. Upon the other hand, the public must be made to entertain just conceptions of the actual menace to life and health resulting from an improper hygiene, and in consequence be stimulated to brook no infringement of sanitary laws by ignorant offenders.

Attention has been called repeatedly to the importance of a proper disposal of the sputum, to the necessity of absolute cleanliness on the part of the consumptive and those about him, to the care of the person and clothing of the invalid, to the importance of fresh air, proper ventilation and sunlight, and the avoidance of certain unfavorable occupations. Matters pertaining to the control of food-supplies, proprietary medicines, supervision of factories, department stores, workshops, mills, public buildings, public conveyances, penal institutions, churches, etc., will be presently considered in connection with The Administrative Control of all Important Factors Entering into the Problem of Etiology and Prophylaxis. Attention is now directed to the application, to every-day life, of some of the general principles of prophylaxis already enumerated.

In view of the prevalence and fatality of tuberculosis in early years, it is important that the education of the public concerning rational prophylaxis should begin with wise counsels and admonitions regarding the *non-procreation of predisposed infants.* While it is perfectly simple to assert, from a theoretic point of view, that the tuberculous should not be permitted to marry, the situation is entirely different when regarded from a practical standpoint. The *marriage of tuberculous individuals* is by no means easy of prevention. Many assume the matrimonial obligations without entertaining the remotest idea of their condition, while in others the first manifestations of a disease previously latent appear some months after marriage, or immediately following parturition. The sweeping prohibition of marriage for consumptives as a class must be regarded at present as both impracticable and unwarranted. A problem so delicate can never be fairly adjusted by recourse to arbitrary

legal enactments, based upon the medical principles of marriage selection and the social aspect of procreation. More properly is it within the province of the physician in his professional capacity to exert such an influence as may be indicated in his own judgment according to the individual circumstances.

It is important for the public to be taught that the existence of tuberculosis should preclude marriage until the disease has become entirely arrested, and then, as a rule, only after the lapse of one or two years. In exceptional instances of partial arrest it may be permitted after a prolonged period of non-recurring tuberculous activity. Even under these conditions, particularly if the *wife* has been tuberculous, procreation should be avoided unless the general condition, social environment, and financial status are exceptionally good. The prognostic aspects of pregnancy have been considered in connection with the Non-tuberculous Complications. To prevent the birth of predisposed children, which is the excuse sometimes offered by practitioners endowed with a flexible conscience, in extenuation of the induction of premature labor among tuberculous women, is utterly without justification. That such practice has been indulged in by quasi-reputable physicians solely upon the basis of tuberculosis in the male parent is almost beyond belief. It is almost unnecessary to state that abortions are devoid of *criminality only* in those cases in which the judgment of *two or more reputable practitioners* indicates that the life of the mother is to be saved by such procedure. Recourse to the evacuation of the uterus under other circumstances is worthy of the most severe condemnation and punishment. The same principles apply with equal force to the attitude of the husband and wife. Deplorable as is the procreation of weakly children by tuberculous individuals, the responsibility of the parents as to the *future* course abruptly ceases once conception has taken place. Thereafter, the decision as to a possible interference with gestation should be passed without hesitation to the conscientious physician, whose action must be based entirely upon the vital interests of the *mother* without regard to the character of the progeny.

With the birth of a child to a tuberculous mother the dangers of *postnatal infection* to an infant already predisposed, are exceedingly great. Under no circumstances should the mother be permitted to nurse the infant, although not solely on account of the possible contamination of the milk by tubercle bacilli. Much greater danger accrues from the ingestion of food insufficient in quantity and ill adapted in quality to meet the demands of a growing child. Another important objection relates to the added drain upon the resources of the mother and the consequent impairment of her resistance to the tuberculous process.

The next consideration of importance relates to the *character* of the food to be substituted for human milk. While the employment of properly selected wet-nurses has its manifest advantages, this means of providing nourishment to infants is very limited in its application. It is necessary, therefore, that the masses be suitably instructed concerning a few important features pertaining to infant feeding. It is perhaps still more desirable that the family physician should devote an interested attention to the nature and manner of preparation of infant foods. All possible protection from tuberculosis must be accorded to the little ones in *supposedly healthy families* as well as

in those known to contain a pulmonary invalid. The development of tuberculosis at a very early age occurs not only from exposure to microörganisms in the household, but from increased *susceptibility* to infection through *impaired nutrition*. It thus follows that the selection and preparation of a food perfectly adapted to the sustenance of the child constitute a vital factor in the warfare against tuberculosis in the very young. This is of infinitely greater importance from a practical standpoint than the employment of measures looking toward the avoidance of milk contamination with bovine bacilli. It has been demonstrated clinically and pathologically, as explained in previous pages, that tuberculous lesions may be produced by the ingestion of bacilli in the milk of tuberculous cows, particularly those with infected udders. Instances of the transmission of the disease in this manner, though comparatively few, are still sufficient to demand a strict enforcement of laws governing the inspection of cattle and of other precautions, as will be described, to avoid bovine infection. While no relaxation of efforts in this direction should be permitted, it is undoubtedly true that more real danger to infants results from ignorance in the selection of artificial foods, carelessness in their preparation, and irregularities of feeding. A discussion at this time of the general principles pertaining to "percentage feeding" for infants is, of course, entirely out of place, but a protest against the indiscriminate unthinking selection of food for the very young seems pertinent in view of the disproportionate interest of the public regarding tuberculosis in cattle, the time, energy, and money expended in the preservation of herds, and the tendency of many phthisiosociologists to ascribe to milk infection an undue prominence in the development of tuberculosis. It may be stated parenthetically that some information has been presented which casts much doubt upon the every-day rôle of milk as the carrier of tuberculous infection to children. Upon the other hand, there can be no question that the health of little ones is seriously impaired by gross inattention to diet.

Aside from the improper preparation of food, a menace to the young is found in the frequent contamination of milk as a result of the presence of nearly all forms of bacteria. It is true that the vitality of these germs may be destroyed by boiling or effective pasteurization, but such measures are not universally employed. Furthermore, little satisfaction may be derived from the thought of ingesting with the milk the filth products of the dairy, no matter how thorough the pasteurization. Sterilized animal feces, though perhaps less objectionable than the unsterilized, are hardly to be considered a desirable constituent of milk for commercial purposes, yet it has been found by actual analysis, that a large proportion of the milk sold in large cities contains all manner of contamination derived from uncleanly dairies. Absolute cleanliness of the stables, of the animals themselves, and of the receptacles for transportation is assuredly a factor of the utmost moment, concerning the importance of which the public should be appraised. Supplementary to this knowledge regarding the prime necessity of purity of milk-supply, there should be generally diffused instructions as to the proper pasteurization, in case doubt may be entertained regarding the observance of proper antecedent precautions.

Another consideration of especial importance in the effort to protect infants from tuberculous infection is the *avoidance of proximity to a consumptive within the household*. The safest course to pursue is

undoubtedly the complete removal of the invalid or the child from the dwelling. This seldom being practicable, recourse must be taken to measures insuring the greatest degree of isolation of the pulmonary invalid, immediate contact with the infant under no circumstances being permitted. When possible, a separate portion of the house and a private porch should be set aside for the exclusive use of the consumptive. The care of the child should be given to a person known to be free from infection, not even the mother, if tuberculous, being allowed to fondle or caress the infant. Kissing upon the mouth by *any one* should be absolutely prohibited. The child should be brought but infrequently into the room of the consumptive mother and should remain only a short time. The infant should not be placed upon the bed of the invalid, nor allowed to play upon the floor of the room wherein the patient is confined. Scrupulous care must be observed with reference to the cleanliness of the hands and person of the consumptive, as well as the clothing and bedding, which must be laundered separately from the family linen in accordance with instructions already prescribed.

The precautions laid down relative to the arrest of possible droplet infection, through the use of gauze or cheese-cloth held before the face in the act of coughing, should be enforced most rigidly when young children remain in the same house. This is particularly necessary on account of the gravitation of bacilli to the carpet or rugs and the prevalent custom, among nurses and attendants, of leaving the little ones to amuse themselves upon the floor. With proper precautions against the distribution of bacilli throughout the room, the habits of children in putting miscellaneous articles in the mouth are attended with much less danger of infection. *Despite* the observance of strict hygienic measures on the part of the invalid, the instinctive practice among infants of conveying to the mouth almost everything that their hands can touch, remains a source of possible danger, and should be prevented in very early life by the watchfulness of the nurse and in later months by admonitory talks. Especial pains should be taken in the modern manner of dusting and sweeping, while the ventilation and sunning of rooms should be made as complete as possible. The sputum must be disposed of in accordance with directions previously described, and, in short, all directions addressed to the invalid must be obeyed more conscientiously than if the dwelling be occupied solely by adults. Even with the strict enforcement of all precautionary rules, there must persist to a degree an element of danger in houses occupied by consumptives. For this and other obvious reasons it is expedient to keep the children in the open air as much as practicable, and to send them away to the country, seashore, or mountains when possible so to do. The children of the poor, to whom these luxuries are denied, should be sent to the open parks of the large cities and kept away from the squalor of noisome tenement houses and dark alleys. While the poverty, ignorance, and misery of their parents residing in densely crowded districts, effectually preclude the acquirement of suitable hygienic conditions at home, the children, as a result of systematic effort, may be drawn to the sunshine, fresh air, and other attractions of the public parks. It is highly important that society should be educated to the point of providing country resorts for the temporary sojourn of unfortunate children, to whom fresh air, good food, and kindly treatment have previously been

unknown. Provision of this character must prove not only a veritable blessing to the poor, but as well a successful feature in the campaign of prevention.

As children advance to the age of *school life*, the problem of prophylaxis assumes still greater proportions. Additional factors are encountered in the housing of a large number of pupils in comparatively small apartments, often with deficient ventilation and improper heating facilities, the more or less intimate contact with tuberculous children, if not with consumptive teachers, and finally the proverbial carelessness of school-children in regard to their personal habits, or an utter defiance of sanitary rules. The selection of suitable sites for school-buildings, the details of construction, inclusive of ventilation and heating, the hygienic care of the rooms, and the general supervision of teachers and pupils will be discussed in connection with the administrative control of tuberculosis in the following section.

Efforts toward the protection of children should not partake simply of the distribution of printed mandatory rules which, without explanatory interpretation, will be completely ignored in the majority of instances. Attention has been called to the necessity of frequent admonitions on the part of teachers regarding the many sanitary improprieties of school-children, and to the expediency of sending concise circular information to parents in the hope of inculcating habits of personal cleanliness and hygiene.

An important phase of the educational movement to be addressed to parents and teachers for the protection of the young consists of an *appeal to increased resistance* through the *influence of proper nutrition*. It is a matter of common knowledge that the majority of school-children are underfed and poorly nourished. As a direct result they exhibit weakened powers of resistance. Although susceptibility to infection is greatly increased by the feebleness of constitution and anemia thus engendered, the demands of a growing child in the way of superalimentation are but little appreciated by parents. Opportunity to receive light nourishment between meals is not afforded to school-children, no matter how urgent the need, save in the hasty swallowing of candy, corn-balls, or other sweet preparations at recess. In some cities the one session system is in vogue, admitting merely of the ingestion of a cold lunch at the noon hour. Whatever may be the supposed advantages of the single session which ends at three o'clock in the afternoon, it is difficult to understand how sufficient benefit can be derived to compensate for the loss of a hearty meal partaken at home in the middle of the day. It is high time that the attention of parents and educational authorities be directed to the actual needs of a large proportion of children for decidedly more nourishment than is provided for them at present. Even the serving of milk or sandwiches at recess, as recommended by Dr. S. A. Knopf, would be productive of excellent results—assuredly more satisfactory than the purchase of fruits and sweets.

Other features in the cause of prevention among school-children concerning which the public should be instructed are the advantages of daily *class breathing exercises*, with other systematically conducted gymnastics, and the necessity of *clothing* more *perfectly adapted* to seasonal requirements. The distinct benefits afforded by carefully performed respiratory gymnastics are too well understood to justify

enumeration, but it is important to bear in mind that under proper conditions of weather their efficiency may be increased if conducted in the open air. Insufficiency of clothing is undoubtedly a factor of some importance in the development of conditions favoring the spread of tuberculosis among children. In fact, the inadequacy of dress among the young is such in many cases to occasion wonder that even a greater number do not become susceptible to infection. It is idle to comment upon the necessities of the very poor and the inevitable paucity of their clothing, but to supply the needs of such unfortunates falls within the province of charitable if not antituberculosis organizations. It is worthy of comment, however, that the children of the well-to-do are sometimes clothed as improperly as those whose parents are in less comfortable circumstances. Discretion and good judgment in the matter of children's dress do not always go hand in hand with a fortunate financial status. While any discussion bearing upon the details of needed dress reform for children, particularly girls, is hardly appropriate in connection with the prophylaxis of consumption, it is, nevertheless, opportune to call attention to the fact that among children far less consideration is given to the proper protection of the body than among adults. This is particularly true with reference to the insufficient covering of the limbs, the use of unsuitable undergarments, the frequent absence of rubbers, stout shoes, warm gloves, or heavy outer apparel. The correction of this treatment of young children constitutes one feature of the movement toward popular education.

By all odds the most glaring and vicious abuse of the young, which also represents a most potent factor in the development of tuberculosis at an early age, is found in the *employment of child labor*. Opportunities for diversion and recreation in the open air are absolutely essential for the nurture and well being of children. The wanton restraint of natural health-giving proclivities, with denial of fresh air and sunshine through long hours of confinement in ill-ventilated workshops, results in an early acquired predisposition to tuberculosis. The public, which blindly permits criminal disregard for the laws of health, decency, and humanity through failure to enact and enforce regulations pertaining to child labor, must be prepared to pay the penalty exacted. This relates to the creation of fresh centers of tuberculous infection, the greater distribution of other diseases, the development of alcoholism and various forms of dissipation, the tendency toward youthful degeneracy, the increased suffering of families, and an economic loss to society of no mean proportions.

In the *years of approaching manhood and womanhood* young people should be urged to lend attentive ears to the lessons of hygienic science, in their relation not only to ventilation and cleanliness, but more particularly to the baneful effect of alcohol, and the detrimental physical consequences of late hours, with other forms of overindulgence. Prolonged and undisturbed sleep at this time of life is prerequisite for sound health and physical endurance. Intemperance of any kind, be it alcoholic or athletic, a reckless abandonment to social dissipation, or an undue devotion to study, must surely sap the energies of the young, and impair their usefulness in after-life, if not making them an earlier and easier prey to the consuming ravages of tuberculosis. In later years a similar diminution of individual resistance is found in the nervous and physical strain incident to overwhelming business cares and

responsibilities, the dabbling in speculation, with its frequent financial reverses, and the multitudinous social and domestic obligations devolving upon the modern housewife even in small families. It is, therefore, of the utmost importance in the midst of the insistent demands imposed by an active, if not strenuous, civilization, that due cognizance be taken as to the inevitable drain upon individual resistance, and the vital necessity for all possible conservation of energy. It should be made clear that undue alcoholic stimulation directly predisposes to tuberculosis, and in no wise retards the advance of an infection once established. Its pernicious influence upon the physical health and the development of character should be explained in the school-room through the use of reputable text-books expounding clearly, without hysteric distortion of facts, its physiologic action and toxic properties.

Young men, enamored by the glitter of abnormal athletic accomplishments, should be warned of the inherent dangers resulting from the continuous practice of arduous feats. While a sane indulgence in nearly all forms of outdoor sports tending to healthy physical development and recreation should be encouraged, no means should be spared to acquaint the young with the folly of the slightest indiscretion in their ambition to excel in this respect. As stated in earlier chapters, clinical experience bears out the assertion that athletes are especially prone to tuberculosis and succumb to the disease even more readily than those unaccustomed to feats of prodigious strength. The loss of sleep and of mental rehabilitation entailed by excessive social indulgence or overstudy should be *emphasized* to the youth as an unfailing cause of nervous strain and physical impairment. The consequences of overtaxing the resources of the individual and the increased likelihood of tuberculous infection should be made a matter of common every-day knowledge.

CHAPTER LXXXVIII

ADMINISTRATIVE CONTROL

Considerable stress has been laid upon the necessity of organized effort for the education of the *masses* as a fundamental factor in the successful control of tuberculosis. In spite of a vigorous educational propaganda already inaugurated by enthusiastic workers, there is still exhibited a deplorable degree of public apathy and indifference. It is apparent that such enlightenment of the people as will insure an active universal movement toward prevention can be effected only through the process of years, pending which it is essential that aggressive restrictive measures be instituted, when necessary, by public authorities. In order at this time to secure a beginning control of the pestilence, it becomes the duty of the Commonwealth to exercise an arbitrary supervision over certain features of the tuberculosis problem. The necessity of compulsory notification and registration has been discussed at some length, as well as the advantages accruing from public institutional provision for indigent consumptives. Other dominating considerations in the matter of administrative control relate: (1) To the suppression

of promiscuous expectoration in public places; (2) the regulation of schools; (3) the inspection of food-supply; (4) the control of patent medicines and the restriction of medical practice; (5) the demand for hygienic construction and sanitary supervision of public buildings and conveyances, factories, tenement houses, and commercial establishments.

Control of Expectoration.—Indiscriminate expectoration is known to be responsible in a large measure for the transmission of consumption from one individual to another. With a suitable disposal of the sputum under all circumstances, tuberculosis would undoubtedly diminish to a vast extent, and it would seem, therefore, that the enforcement of stern measures looking toward the mitigation of the spitting evil should become obligatory upon all municipal authorities. It also appears that no valid objection can be interposed on the part of the public against the summary suppression of the nuisance. Society has been informed repeatedly as to the direful consequences of indiscriminate expectoration, yet this disgusting practice is indulged in daily by *careless, non-ignorant* individuals, who are utterly indifferent to the rights of others. Regulations have been enacted to abate the indecent and pernicious custom, placards of warning have been posted in street-cars and public places, but even ruthless violation of the law is seldom followed by arrest or the imposition of a penalty. It is evident that ordinances governing this practice must remain a dead letter until public sentiment is awakened to a realization of the actual danger from an unclean and inexcusable habit. When the happy state of affairs shall be reached that society will rise in its wrath, demand the rigid enforcement of the law and the exaction of the maximum punishment to violators, no longer will the public eye be offended by unsightly printed notices calling attention to a personal, if not national, impropriety. The necessity for such signs is indeed a reproach to the intelligence and civilization of any community in which they are exhibited. While considerable opposition may be expected in many localities from the arbitrary execution of the anti-spitting ordinances and much personal humiliation unavoidably imposed, the remedy for the evil lies at present in the summary action of fearless municipal authorities. Verbal warnings to pedestrians or the handing of printed cards have thus far proved of slight avail. In some cities the practice of indiscriminate spitting has been curtailed to a great extent. It is, of course, apparent that the people must have some place in which to expectorate, and should under no circumstances swallow the sputum. To those unprovided with pocket cuspidors or gauze, opportunity should be afforded to expectorate in closed sanitary cuspidors in public places. These should be self-flushing, with sewer connection.

Regulation of Schools.—The regulation of schools and school life should begin with the selection of a proper site. An open elevated space should be reserved if possible for this purpose in sections removed as far as practicable from tall buildings or large chimneys. Wherever the location, it is absolutely essential that the playground be spacious and well kept. An important function of municipal government pertains to the supervision of the construction of school-buildings. Important details to be observed are the facilities for ventilation, sunshine, and heating. All rooms should be high posted and provided with numerous large windows, which should be kept open, whenever possible, without subjecting the occupants to direct drafts.

Forced ventilation should be employed in all buildings of this nature, the hot air being driven into the upper portion of the room and an exit provided near the floor. Experience has shown that a properly equipped ventilating and heating apparatus should provide a complete change of air within a very few minutes, and yet maintain an equable temperature within the room. For this purpose the entrance of cold air in the basement is followed by its passage over a tempering coil, by means of which the temperature is raised to the neighborhood of from sixty-five to seventy-five degrees. It then is forced by means of a fan into a mass coil chamber, from which exits are provided to different rooms, the temperature being regulated by dampers automatically adjusted by thermostats. The heated air should be driven into the rooms at a distance of about eight feet from the floor, permitting its circular distribution and diffusion to all portions of the apartment. The exit near the floor should be upon the same side of the room as the point of ingress, in order to avoid a direct draft. By a proper adjustment of all parts of the heating and ventilating plant according to the size of the room, it is estimated that from 2500 to 3000 cubic feet of fresh air may be supplied to each pupil in the course of an hour.

It is desirable that the greatest degree of care should be observed in the daily cleaning of all school-rooms, this being performed strictly in accordance with modern methods, which preclude the raising of any appreciable quantity of dust. School-rooms ought not to be used for public or social gatherings in the evening, on account of the difficulty in obviating the danger of careless expectoration. If used for lecture purposes, the rooms should be thoroughly aired before the children are permitted to reënter, and the floors and desks washed with a weak solution of formaldehyd. It is unwise to employ any teacher who is known to have tuberculosis, and the presentation of a certificate of health from a recognized authority ought to accompany all applications for positions. In case of doubt, the teacher should be compelled to submit to an examination by competent medical men designated for this purpose. Children should be required to pass inspection from time to time by medical examiners, who should make periodic visits to the various departments and conduct a physical inquiry whenever necessary. No pupil found to be the subject of tuberculosis should be permitted to attend school, and no employe suffering from the disease should be retained in his position. All teachers found to have contracted tuberculosis while in the discharge of official duties are justly entitled to retirement upon one-half or one-third pay. It is well known that no class of people occupying equally responsible positions receive such inadequate remuneration as the teachers in our public schools. Society can well afford to donate an annual stipend to those incapacitated by disease, which was acquired while in active service.

Inspection of Food-supply.—The control of animal food-supply must embrace an administrative supervision of dairies and slaughter-houses, with a detailed inspection of their products. It is not sufficient to rest with the employment of the tuberculin test upon cattle at infrequent intervals. All establishments should be subjected to rigid investigation from time to time, and facts elicited as to the conditions under which the animals are housed and kept. Cleanliness of the stables, cows, attendants, and utensils must be regarded as a *sine qua non* for the issuance of a license, without which no farmer should be permitted

to sell milk. It is essential that the control of these matters should include a definite limitation of the number of cows to be cared for by each attendant. It has been the dictum of some students and educators for years that all cattle responding to the tuberculin test should be condemned, the loss being sustained either by the State alone or jointly with the owners. The experiment has been tried in several States and found almost impracticable, on account of the prohibitive cost even when a portion of the loss is borne by the owner. Bovine tuberculosis, however, as shown by herd inspection, has become somewhat less prevalent in these States. In the light of recent scientific research it is clear that immunization of cattle may be reduced to a practical working basis through the inoculation of attenuated living cultures of tubercle bacilli, thus minimizing the magnitude of the annual loss to owners of cattle.

The inspection of all animal food offered for public consumption should be made as thorough as that practised by the federal government in relation to the meat offered to the export trade. In some instances the meat intended for home consumption throughout the United States is either not inspected at all, or so superficially as to rob the procedure of any practical value. The control of the milk-supply should consist of more than the detection and correction of impurities or diluents. While the maintenance of a required standard of milk should be enforced by municipal authorities, it is important that there be instituted a strict surveillance of the animals and premises where the product is obtained. No milk from tuberculous cows should be offered for sale, and such animals, if not destroyed, should be segregated from the rest of the herd during the employment of the vaccine treatment. Competent and fearless inspection of dairies is not to be expected if appointments to the position are obtained as a mark of political preferment. Devotion to the work, attention to detail, and the strictest integrity and impartiality, combined with the courage of one's convictions, are essential qualifications for those upon whom devolve the responsibilities of food inspection.

Control of Patent Medicines and Restriction of Medical Practice.—The patent medicine evil is responsible for many of the ills visited upon mankind during the present generation. Through the influence and under the auspices of the American Medical Association recent attention has been called in a convincing manner to the prodigious consumption, and the detrimental effect upon the health of iniquitous preparations foisted upon the public under the name of proprietary medicines. The vast majority of these nostrums contain large percentages of alcohol, to say nothing of other injurious substances, the nature, dosage, and effect of which are entirely unknown to the consumer. An infinite amount of harm is produced by the swallowing of these deleterious preparations, which are offered to an unsuspecting people under the guise of harmless remedies. The proprietors, unhandicapped by scientific knowledge or conscience, usually succeed in enlisting for a *consideration*, the coöperation and assistance of otherwise reputable citizens. Flamboyant advertisements as to the virtues of these preparations, guaranteed to cure all diseases of men, women, and children, are often accompanied by testimonials from clergymen and men in public life, together with their photographs. It is worthy of more than passing comment that the more glaring the deception, the more pernicious the nostrum, and the more extravagant and unreasonable the claims of

promoting fakirs, the more likely are quasi-intelligent citizens to become inveigled into lending their unqualified indorsement. Waiving the manifest impropriety in permitting their names to be attached to false and blandishing testimonials, the situation is dominated by the deplorable fact that these well-meaning people are instrumental in the production of untold misery and in abetting an evil which represents one of the greatest curses of our present civilization. It is, indeed, to be regretted that some reverend gentlemen, even though unintentionally, should assume the fearful responsibility of leading others to lives of alcoholism and habits of cocain degeneracy. Were the extent of the nuisance limited to a financial loss on the part of the people, or even to the delay thus occasioned in seeking competent medical counsel, the evil would still assume sufficient proportions to demand the enactment of vigorous legislative measures toward its suppression. Unfortunately, however, the baneful consequences of yielding to alluring advertisements of this nature are decidedly more far reaching. Recourse to quack nostrums on the part of the ill is often attended with loss of valuable time before the recognition of the disease and, *worse still*, loss of the opportunity to secure arrest. In view of these considerations of fact relating to the undermining of health, there is imposed upon the State an obligation to restrict the wholesale consumption of these fraudulent and vile concoctions, and to control the *character of medical advertisements* in the public press. The American people are greatly in need of protection from unscrupulous and ignorant vendors of sure cures for consumption. The loss to the unfortunate victim of these pretentious discoverers of special methods of treatment is quite beyond the power of estimation. The poor, who constitute the class more frequently deluded by their representations, are robbed at the very beginning of the savings of a lifetime. After the lapse of a few weeks or months, during which they have dragged themselves wearily to offices for the inhalation of pungent or aromatic vapors, they are wantonly left to their own resources, ill prepared, by reason of impaired finances and abandoned hope, to cope with the exigency of their present situation. While reputable physicians, impelled to seek change of residence in the various States, are subjected to much unnecessary embarrassment in order to qualify satisfactorily before State examining boards, the law in many localities refuses to take cognizance of the iniquitous practice, indulged in by unworthy and degenerate physicians, who have previously succeeded, through devious means, in securing diplomas or passing examinations.

THE DEMAND FOR HYGIENIC CONSTRUCTION AND SANITARY SUPERVISION OF TENEMENT HOUSES, WORKSHOPS OR FACTORIES, COMMERCIAL ESTABLISHMENTS, PUBLIC BUILDINGS, AND CONVEYANCES

The regulation of tenement-house construction through legal enactment constitutes, without doubt, an exceedingly important feature of administrative control. While there can be no excuse for the faulty construction of such buildings, containing an innumerable quantity of small dark rooms and furnishing an abode for countless people, it must *not* be assumed that absence of sunshine, insufficient ventilation, and unsanitary plumbing are the *only factors* responsible for making these structures prolific breeding-spots for tuberculosis. The squalor, filth, misery, ignorance, and poverty of the occupants are assuredly not to be

ignored as important etiologic considerations. These unfortunate conditions would obtain to a large extent even were such buildings constructed in accordance with sanitary regulations. Without the observance of *general hygienic* conditions by people dwelling in tenement houses, municipal prophylactic efforts would remain unavailing even in rooms of adequate size, with large windows permitting the entrance of sunshine and fresh air. Upon the other hand, in small, dark, ill-ventilated rooms and halls, the maintenance of perfect cleanliness is insufficient in itself to prevent the deterioration of health and the development of physical conditions favoring infection. While impure air and excessive crowding of people within a limited area, are important factors in the development of tuberculosis, these are accentuated by the filth, and utter neglect by tenement-house occupants to observe sanitary conditions.

Some students of medicosociologic affairs have described in graphic terms the criminal disregard for the laws of hygiene in the building of tenement houses, to which is ascribed a large measure of the responsibility for the spread of tuberculosis. An abuse of this kind constitutes but a single factor in the general problem pertaining to the development of consumption among a class of people peculiarly predisposed as the result of a great variety of causes. It is true that an appalling prevalence of tuberculosis has been observed in the tenement-house districts of many of our larger cities. Certain blocks have been designated as "lung blocks," by reason of the frightful distribution of the disease in these localities. It is also true that the ignorance and filth in these places are quite as revolting as the faults of building construction. The tenement-house evil, therefore, seems to present two important indications for immediate reform, *i. e.*, the regulation of construction by State or municipal government, and the removal of squalid unsanitary conditions.

The preceding considerations apply with almost equal force to workshops and factories, and, in fact, to all manufacturing and commercial establishments. Certain occupations have long been regarded, both by the laity and the profession, as inimical to health.

Attention has been called to the prevalence of the disease among cigar-makers, shoemakers, tailors, machinists, factory operatives, laundry workers, stone-cutters, and upholsterers. It must be admitted that a few occupations directly favor infection on account of the unusual opportunities afforded for the inhalation of fine particles of dust, which may serve not only as carriers of tubercle bacilli, but also as agents of irritation to mucous surfaces. This is particularly true of weavers, millers, machinists, stone-cutters, miners, and potters. It is probably true, as has been described, that the detrimental effects consist, in part, of the development of chronic catarrhal conditions of the mucous membranes, as a remote effect of which the resistance to tuberculous infection is diminished. There are many other pursuits, however, exhibiting a frightful mortality rate from tuberculosis, in which the inhalation of dust from any source cannot be regarded as a definite etiologic factor. The disease, however, has been supposed to claim an appalling number of victims by virtue of some mysterious influence incident to the occupation. In many instances there obtain widely diverse unfavorable conditions, which are definitely responsible for the development of consumption. These are not always peculiar to the occupation and

the conditions under which workmen are employed, but are inherent, to some extent, to the particular class of people engaged in these pursuits, their previous methods of existence, their poverty, shiftlessness, and habits of dissipation. Thus the ignorant and underpaid employe in certain lines of work, which demand but little intelligence or training, is non-resistant to disease not merely through a direct detrimental effect of the occupation, but also from deficiency of nourishment, inadequateness of clothing, and the physical drain incident to previous disease. Carelessness of expectoration and other habits of personal uncleanliness in the workshop are much in vogue among employes of the foregoing description. It is precisely among such a class of people that squalor and filth abound, and it is quite as reasonable to attribute the development of consumption to the effect of the ten or fourteen hours spent in the home as to the eight or ten passed in the workshop. It is not desired to minimize the unfavorable influence of certain occupations, nor to disparage the vital need of better facilities for ventilation and other details of hygienic building construction. The point is raised, however, that a broad consideration of the problem of prevention demands in many individual instances the inclusion of other factors than the occupation itself. While employes of mills, factories, steam laundries, manufacturing and printing establishments are often compelled to work in overheated and poorly ventilated apartments, operatives engaged in other industrial occupations are often prone to *neglect* hygienic considerations. There has been advanced no substantial reason why the shoemaker, from the nature of his work, should be especially liable to the development of tuberculosis, either from direct exposure or through diminution of individual resistance, yet the highly unfavorable conditions under which he has been wont to toil have been responsible for an alarming mortality rate. The shops have almost invariably been contracted, low posted, and dingy, located either in some dark recess or basement, unprovided with ventilation of any description, and often superheated to a degree of intolerance.

Consumption has been found to be quite prevalent among the employes of large commercial establishments, the chief injurious factors being the indoor confinement and deficiency of ventilation. It is important in such places and in all workshops that there should be adequate provision for air-renewal. In many department stores the facilities for ventilation are crude and imperfect, and as a result of the influx of people, the clerks for hours at a time are compelled to breathe a noxious atmosphere. Details of hygienic construction should be arranged in accordance with the purposes for which such buildings are intended.

The necessity of proper construction and careful supervision applies strongly to public buildings of all description. It is a regrettable fact that a large proportion of the buildings designated for the use of the public, possess exceedingly inadequate facilities for ventilation, particularly post-offices, federal buildings, court-houses, and in many instances State capitols. Even the halls of such structures, where people are wont to congregate or pass to and fro, are often redolent with foul air and sometimes offensive from the aggregation of filth. Cuspidors, if provided at all, are usually of improper construction, rarely, if ever, filled with water, and, as a rule, insufficiently cleansed. The necessity for attention to details of hygienic construction and per-

fect sanitary cleanliness appears emphasized by the indifferent habits of individuals frequenting such buildings.

In all commercial establishments and factories, as well as in public buildings, rules against indiscriminate expectoration should be rigidly enforced, and sanitary cuspidors universally provided. It is insufficient to post notices in workshops warning employes of the dangers of consumption and calling attention to the necessity of compliance with detailed instructions. *Coöperation* of operatives must be secured in order to make any organized effort effective. To this end the employes should be privileged to receive the periodic attendance of a physician free of expense. By this means the disease may be recognized at an early stage, and the invalid excused from the workroom, or at least subjected to the closest surveillance. This advances an important feature in the control of tuberculosis, *i. e.*, *provision for the detection of consumption* among employes and for their *financial assistance* when *incapacitated* by disease. This idea has been amplified to a considerable extent in Germany, where a system of compulsory insurance for working-people is in vogue. In 1881, under the influence of Kaiser Wilhelm der Grosse, workingmen's insurance was instituted to combat, as far as possible, the misery and poverty of a portion of the laboring class.

The operative in Germany, who is compelled by law to join the Government Assurance Association, becomes insured against sickness, accident, invalidity, and old age. When incapacitated for these reasons he is entitled to assistance for himself and family, and a vast amount of distress is effectually prevented. The workingmen are divided into various classes in accordance with a certain wage scale. The premiums of sick insurance are paid through the employer, who contributes one-third of the entire amount, deducting the other two-thirds from the wages of the employe. In case the latter, through physical disability, becomes unable to work, he receives an allowance equal to one-half his wages for a period of many weeks and sometimes a year, and receives, in addition, free medical attention. Provision of a somewhat similar nature is made for workingmen insured against accident or invalidity. Insurance against old age and invalidism is compulsory to every person following certain prescribed pursuits, over sixteen years of age, whose annual wage earnings do not exceed $500. Through the beneficent influence of these various forms of insurance, merging more or less into one organization, results of a highly important nature from an economic and humanitarian standpoint have been secured. An essential feature of the proposition is the governmental aid, protection, and paternalism so highly characteristic of the general social policy in Germany. Although a portion of the burden in the payment of premiums is borne by the wage-earner, there is introduced, at the same time, the element of governmental coercion, intelligently elaborated to meet the necessities of unfortunate social conditions. While it is not believed that in America a detailed interpretation of the German insurance laws for workingmen could be tolerated on account of the spirit of individual independence, the fundamental principle of coöperation and assistance in its practical application to the needs of wage-earners is endowed with enormous beneficent possibilities. Certain modifications of the German system for years have been in vogue among the employes of large railway corporations and other industrial establishments. These voluntary relief associations, which sometimes partake more or less of the nature of fraternal

organizations, have proved to be immensely effective in diminishing distress at the time of sickness.

Especial importance attaches to the question of *prison reform*, as tuberculosis has ever been found prevalent in penal institutions. While the disease is known to flourish among those who are permitted physical and mental occupation in the workshops, statistics indicate a particularly alarming mortality rate among convicts subjected to close confinement. Although there are certain mitigating conditions to be offered in explanation of the spread of tuberculosis in prisons and reformatories, a few facts may be adduced which even magnify the abuse of hygienic laws permitted in these institutions.

Many prisoners, when admitted to State penitentiaries, have been addicted for years to dissipation, and afflicted with direst poverty. Some of these unfortunates have become tuberculous as the result of excesses practised during lives of misery and degeneracy. The law, not recognizing that tuberculosis is any excuse for crime, exacts the same penalty from the sick as from the well. Phthisical individuals are not subjected to physical examination before being sent to these institutions, and, therefore, are a decided menace to their fellow-convicts for indefinite periods before their true condition is recognized. Many are sent to the crowded workshops to pursue some industrial occupation, in close proximity to others. Some, though permitted employment in the open air, are compelled to perform arduous labor far beyond their physical strength. Still others, who are subjected to solitary confinement, are necessarily denied fresh air, sunshine, and nourishing food, all of which are demanded for their unsuspected tuberculous condition. The effect of these injurious factors is materially augmented by the psychic influence of restraint, the absence of mental diversion, and the conflicting emotions obtaining in the majority of those convicts upon whom the solitary confinement is imposed. Added to these influences are carelessness in the personal habits of the inmates, and the imperfect ventilation of cell-houses, corridors, and all rooms occupied by convicts for industrial purposes.

Some criticism may justly be directed to the imperfect details of architectural construction and the lack of enforcement of necessary hygienic regulations by prison authorities. In institutions where discipline in all other respects is the supreme desideratum of officials, the vital element of hygienic régime should not be disregarded. Sanitary cuspidors should be provided for the convicts and instructions issued with reference to the proper disposal of the expectoration, violation of rules being subject to reasonable punishment. There is no reason why the cells and corridors should not be kept scrupulously clean, and why blankets and bedding should not be disinfected periodically. A systematic investigation from time to time regarding the physical condition of the inmates appears absolutely essential as a preliminary feature of any general effort toward prevention. Proper ventilation should be provided for the cells, cell houses, and workrooms, the entire problem of fresh air-supply being as obligatory upon the attendants as any other feature of prison discipline. It is desirable that the work which any inmate is designated to perform, should be adapted to his physical condition. The pulmonary invalid, if compelled to work, should at least be permitted to engage in some light occupation in the open air which may not be altogether detrimental to his physical health.

The supervision of sleeping apartments in hotels, Pullman cars, and steamboats must be regarded as an important step in any organized movement toward prevention. But little has been done in any State in the way of supervision of hotels, although in some localities circular information has been freely distributed. There should be an obligatory notification of the reception of consumptives within the hostelry or boarding-house, after which the health officers may enforce the observance of all sanitary precautions, both on the part of the invalid and the attendants. Thorough disinfection of apartments, inclusive of carpets, rugs, furniture, clothing, blankets, and linen, occupied by consumptives should be made fully as obligatory in hotels as in private families.

Especial interest attaches to the supervision of public conveyances, and particularly to the enforcement of radical precautionary measures in Pullman sleeping-cars. From a practical standpoint, the opportunities for infection during transportation are comparatively slight in ordinary day-coaches and electric cars. As people usually ride but short distances in these conveyances, the accumulation of filth and the scattering of oral excretion are rather inconspicuous. Upon long journeys advanced pulmonary invalids are often confined in sleeping berths for several days. The facilities for ventilation are much better in the former conveyances, as the doors are opened more frequently and greater opportunity afforded for direct draft than in the Pullman cars, with their winding passages. Therefore, in sleeping coaches the possibility of infection during transportation is of especial concern, and the necessity of stringent regulations a paramount consideration. In these conveyances many objectionable features are almost unavoidably encountered, among which must be mentioned primarily the presence of unfortunate consumptives, particularly upon trains running to and from popular health resorts. Many of these individuals, exhausted by disease, are compelled to remain in the drawing-room or berth, while the cough is often aggravated by the maintenance of the recumbent position and the inhalation of smoke and dust. Innumerable bacilli are scattered throughout the immediate vicinity of the invalid as a result of the droplet infection incident to violent cough. The expectoration is often deposited upon handkerchiefs or in receptacles utterly inappropriate for this purpose. Masses of sputum remain adherent upon the upper surface of shallow cuspidors, and are exposed for long hours to the confined and overheated air, while blankets and linen are almost inevitably soiled by the excretions from the mouth.

No opportunity is afforded *en route* for proper ventilation or for sweeping and dusting in accordance with modern methods. Neither is it possible to effect an immediate sterilization of blankets, which are packed away without exposure to the sun or fresh air. The cars, as a rule, are either greatly overheated or uncomfortably cold, the maintenance of an equable temperature with adequate ventilation being necessarily attended with the greatest difficulty. People obliged to travel long distances, therefore, in addition to the other discomforts, are often subjected to direct exposure to tuberculous infection. Another factor of some importance is the attention of the porter, who becomes ubiquitous at the *end* of the journey, and with the ostentatious flourishing of the whisk, raises clouds of dust in the faces of passengers. It is apparent that public protection during transportation in these

conveyances can be secured only by the enactment of uniform regulations throughout the United States, enforcing the maintenance of sanitary conditions. Some States have already passed laws pertaining to car sanitation within their borders, while others have made no effort to secure similar legislation. Much praise should be accorded to the Pullman Company for the hygienic efforts undertaken upon their own initiative. During recent years the interior furnishing of Pullman cars has been made more simple, thus permitting greater ease and thoroughness of cleaning. Some of the upholstery has been dispensed with and a portion of the carpeting, while rubber tilings have been placed in the lavatories and smoking-rooms. A third sheet has been provided to protect the upper blanket, thus minimizing materially the danger of wholesale distribution of bacilli upon the woolen fabric. Dr. T. R. Crowder, Superintendent of Sanitation for the Pullman Company, states that immediately the car enters the yard after completing the trip, the seats, cushions, carpets, blankets, and bedding are cleaned out-of-doors by means of compressed air. If a single berth is known to have been occupied by a consumptive, the interior woodwork is cleaned with moist cloths and the entire car fumigated. For the purpose of disinfection, formalin is left to evaporate, with all the berths open, for a number of hours. Supplementary to the commendable work undertaken by the company in the interests of more perfect sanitation, it is suggested that some changes are needed in the disposal of the sputum. Undoubted dangers accompany the use of the cuspidors now in vogue, and yet manifest disadvantages, if not insuperable objections, attend the employment of sanitary floor receptacles for sputum. Cuspidors at present in use are shallow, of small size, incapable of holding water or a disinfecting solution, and quickly become filthy by the retention and drying of sputum upon their upper surface. Upon the other hand, high cylindric cuspidors containing liquid are apparently precluded by the necessity for economy of space and the continual motion of the train. For these reasons it appears that some other provision should be made for the disposal of the sputum than the use of floor cuspidors. It should be made obligatory upon pulmonary invalids traveling in these conveyances to be equipped either with sanitary pocket cuspidors or with cheese-cloth and bags of paraffined paper, oiled silk, or rubber. The dry sweeping of cars and indiscriminate dusting either of seats or individuals should not be permitted in transit. Considerable difficulty is to be experienced in securing a proper degree of air-renewal on account of the objections raised by passengers. Conductors, brakemen, and porters, however, should be instructed to give particular attention to the maintenance of as thorough ventilation as is practicable by means of the doors, windows, and transoms.

SECTION II

TREATMENT

CHAPTER LXXXIX

GENERAL CONSIDERATIONS

THERE is demanded in the management of no disease in the entire realm of medicine the exercise of such skill and judgment on the part of the physician as is required for the intelligent treatment of the clinical manifestations and for the resourceful control of the tuberculous individual. It is doubtful if the trained clinician, accustomed to definiteness and accuracy of opinion born of wide experience, is compelled to observe a greater regard for detail or a more sagacious adaptation of means to satisfy imperative and often conflicting indications, than in the individualized treatment of pulmonary hemorrhage.

Notwithstanding the urgent claim upon the profession for a sustained support of rational conservative measures of treatment, there ever has been in evidence a lamentable diversity of therapeutic methods. Even in recent years numerous remedies and widely divergent methods have been highly vaunted for their supposed efficacy. Without a wise, judicious guidance, it is almost impossible for the student in perusing the literature extant, to select the authentic reports, the substantiated facts, and the mature conclusions from the superficial observations, the erroneous deductions, and the fanciful theories. It is not pleasant to contemplate the many vagaries of medical opinion and the therapeutic absurdities practised even in recent generations. No comment is necessary concerning previous inconsistencies of treatment other than to note the facility with which men of apparently sound minds have been led to embrace unworthy therapeutic methods. It is fortunate that the tendency is growing to refuse a blind and unthinking acceptance of prevailing medical fads with reference to the management of a disease which, more than all others, demands the exercise of conservatism and stability of judgment.

Even at the present time there is occasionally manifested an inclination toward the formation of hasty conclusions, the presentation of inaccurate data, and the promulgation to the profession and the general public of irrational opinions with reference to the relative advantages and disadvantages of certain remedial measures. The opinions expressed by some writers in the height of their exuberant enthusiasm over the results of some therapeutic procedures are bizarre in the extreme. Many of the so-called "cures" which are flaunted in the face of the profession and the public by men to be designated merely as "optimistic" are, in reality, not subject to verification upon the basis of the physical and bacteriologic findings. While consumption is, indeed, curable, it is essential for the public to be informed that enduring success in this respect is not as beatifically simple as might be supposed from some of the current literature. It is desirable that the people should be thoroughly aroused from the lethargy and resignation prevailing in

former years as to the fatality of consumption, but with the dawn of renewed hope, it is highly important for them to understand that the effort to regain health is fraught with no slight degree of individual responsibility, and that success may be attained only through wisely directed personal endeavor.

Consumption, though distinctly subject to arrest, is by no means cured in all instances. If recognized early, the possibilities of arrest are surely present, but the personal equation, both of the physician and patient, must remain a vitally decisive factor in the determination of the final outcome. The opportunities presented for a complete ultimate recovery from pulmonary tuberculosis in individual cases scarcely warrant an assumption as to the general or invariable curability of the disease. Yet such a conclusion, regardless of vitally important conditions, has become a war-cry of some of the "crusaders."

It should be understood that the term "curability of tuberculosis" is necessarily subject to considerable flexibility in its general application and in the interpretation of its meaning. To the public, the impression has been conveyed that "cure" is synonymous with absence of subjective symptoms and restoration of working capacity. To the profession a literal definition of "cure" represents the entire disappearance of physical and bacterial evidences of the disease. There is also implied an obliteration of the tuberculous process through fibrous tissue proliferation, or at least the enduring encapsulation of tubercle bacilli within the barriers, which encompass the previous foci of infection. It is, of course, obvious that a large number of cases fail to attain a technical cure even though all clinical manifestations of tuberculosis have disappeared. Despite an apparent restoration of health with resumption of physical activity and usefulness, the supposed recovery is not founded upon a strictly anatomic basis. By what token may it be assumed in individual cases that the connective-tissue formation is sufficiently dense to produce obliterative focal contraction or to imprison effectually the bacilli within encircling walls? Clinical experience attests the facility with which, even in the midst of apparent recovery, there is finally secured an avenue of escape for bacilli through a cordon of connective tissue, and their subsequent access to uninvaded pulmonary areas, or the development of metastatic foci of infection in other portions of the body. It is evident that unqualified statements addressed to the public relative to the *general* curability of tuberculosis should be carefully avoided in order to forestall popular distrust and misconception. Even in supposedly favorable cases the expression of precipitate conclusions regarding a successful issue should be rendered with the utmost conservatism, that erroneous ideas may not be disseminated, and that individuals may not be doomed to eventual disappointment.

Some observers have seen fit to exalt the practical utility of certain therapeutic agencies to a point far beyond their due value. Others have deigned to renounce *in toto* the benefits accruing from methods of undoubted efficacy. A just and well-proportioned estimate of the true importance attaching to the many phases of therapeutic effort is entertained by comparatively few physicians presuming to direct the destinies of pulmonary invalids. It is believed that the best interests of the consumptive are subserved, if there be accorded by the medical attendant a recognition of the importance of the following general principles of management.

PRINCIPLES OF MANAGEMENT

The existing status of medical opinion regarding the rational management of tuberculosis has been stated to be somewhat unique, on account of the considerable lack of uniformity exhibited in the way of therapeutic effort. This appears all the more remarkable in view of the fact that the present consensus of opinion among all qualified observers relates solely to the consideration of outdoor life, rest, superalimentation, and constant supervision as the all-important elementary factors. It is difficult to understand how there can exist such widely differing interpretations of the application of these basic principles as to permit the resulting divergent methods of practice, where harmony of thought and action might reasonably be anticipated.

It is recognized that pulmonary invalids as a class demand, upon the merits of their condition, the fullest conception of an intelligent system of management. This may be attained only through a detailed elaboration of underlying principles, subject to modification according to peculiar individual needs. From numerous sources, however, there is advanced, with perfect integrity of motive, the indorsement of several distinctive methods of treatment which appear unalterably opposed to one another. It goes without saying that a more or less partizan appreciation of their comparative merits is developed by the immediate environment and special opportunities of the observer. Thus is to be explained the repudiation of the advantages of climatic change for any case, or the advocacy of several totally differing localities for nearly all classes and conditions. In like manner is noticed the strenuous insistence by some upon a rigid disciplinary régime within a closed sanatorium, as applicable to all cases of consumption, regardless of many vitally important considerations, and at the same time an equally enthusiastic indorsement by others of the advantageous conditions rendered possible at home. Unfortunately, the picture is sometimes painted in its most dismal colors by ardent opponents. The invalid in the mournful contemplation of banishment to a distant clime, incarceration within the walls of an institution for consumptives, or seclusion upon his back porch, and, perhaps, in an unsightly yard, may often wonder which fate can possess the least terror.

It does not necessarily follow that because one of these methods is rational in certain instances that the remainder are necessarily inapplicable to other cases. Manifestly, each has much of merit, according to the individual conditions imposed, and through the exercise of an intelligent discrimination on the part of the medical adviser may be utilized for the material aid of an appropriate class.

Irrespective of the particular plan pursued, it is of the utmost importance to remember that the efficacy of *all* therapeutic procedures is directly dependent upon their power to *augment* the *inherent resisting* forces of the individual. The natural constructive processes are stimulated only by measures leading to *conservation of strength*. This, then, is the true fundamental principle underlying all general therapeutic agencies in the effort to secure arrest of the tuberculous infection. The accumulation of a substantial reserve in strength is known to take place through the influence of increased nutrition and a diminished expenditure of physical energy. These factors in the problem of management are utilized by an intelligent *regulation of the mode of life*. Another feature

of essential importance is the variation of individual adaptability, which imposes the necessity of a *critical differentiation of cases*. Conceding that each case is a law unto itself and must be adjudged solely upon the intrinsic merits of its many component factors, it appears that a *preconception* of fixed ideas as to the management of consumption must give way to a just recognition of the valid and established claims of *several methods*. The application of the various principles of treatment to an individual constitutes a responsible trust, the satisfactory fulfilment of which can be afforded only through a sufficient appreciation of its true character. The cardinal features to be rigidly observed in the management of all cases consist of: (1) Regard for infinite detail; (2) adjustment of physical or nervous effort; (3) enforcement of an open-air existence; (4) regulation of diet.

CHAPTER XC

REGARD FOR INFINITE DETAIL

THE first great requisite for rational treatment consists not only of a careful preliminary investigation of all phases of the disease, historic, symptomatic, and physical, but also a diligent study of all factors pertaining to the *patient, i. e.*, temperamental, financial, domestic, and social. Only through such means may the clinician hope to arrive at definitely correct conclusions concerning the manner of applying the principles of treatment to the best possible advantage. It is not the most complete interpretation of a *single* feature, no matter how important, that is to accomplish the best results. Neither are these to be obtained by the most radical conception of *several* thoroughly accepted principles, if at the obvious expense of remaining factors, perhaps not as well recognized, yet entirely pertinent to the invalid in question. The fullest measure of success in management is to be secured only by the *wisest possible grouping of all* the favorable influences pertaining to the case. This imposes an obligation for painstaking detail, and necessitates a vast amount of study regarding the special requirements in each instance.

Personal effort directed to a critical analysis of all the phases of each case is absolutely essential in order to afford not only a wise *preliminary* guidance, but also to facilitate subsequently a *continued adaptation* of the consumptive to a proper environment. Thoughtful study and alert vigilance must be maintained throughout the entire period of observation, in order to provide such mode of life and surroundings as are especially appropriate to changing conditions, and in harmony with the varying needs of the patient.

Following a review of the clinical history and an exhaustive examination of the chest, it is my practice to make a brief report of the condition, and to offer such reassurance as is consistent with the facts and seems advisable from first impressions, declining, however, to grant a detailed advisory statement until after the urine and sputum have been examined. This plan of procedure permits not only precise clinical infor-

mation regarding some important phases of the case, but, what is more important, affords not less than twenty-four hours' delay, during which time its many aspects may be reviewed.

It is desirable, in the majority of instances, to transmit to the patient and family some intelligent idea as to the nature of the disease and the manner in which it is hoped to secure arrest. In plain unequivocal language, the information should be conveyed as to the overwhelming importance of the condition and the necessity of implicit obedience to detailed instructions. In general a guardedly favorable prognosis should be rendered, thus offering sufficient encouragement to insure faithful, earnest coöperation. The degree of reassurance to be extended should be carefully adjusted by the clinician in accordance with the temperamental proclivities of the patient. The attitude of the physician toward the pulmonary invalid, who is, as a rule, very susceptible to suggestion, should vary materially with the requirements of the individual case. The vital thought ever to be borne in mind is the fact that the extent of tuberculous infection is often of less importance than the temperamental characteristics of the tuberculous patient.

A perfunctory recommendation of conventional routine measures of treatment is of but little avail, if uninspired by a genuine devotion to the well being of the invalid. As a general rule, the imparting of advice should be accompanied by the exercise of consummate tact in its *adaptability* and *manner of presentation*. Thus the personal equation of the physician becomes a highly important factor, often of greater moment than skill in diagnosis, knowledge of the disease, or familiarity with modern methods of phthisiotherapy. In view of the pronounced individual peculiarities often exhibited by pulmonary invalids, the value of an intelligent directing influence is almost beyond description. Alcoholic dissipation and other excesses should be controlled by stern admonition; foolish optimism, undue exaltation of spirits, and frivolity, by kindly, forcible restraint; mental depression and nervous irritability by constant sustaining hope and encouragement.

Above all, it is important to make clear that a large portion of the credit or responsibility for ultimate results must rest directly upon the patient, the prospects of a successful termination being greatly enhanced by strict conformity to instructions. It should be emphasized that, for the time being, the invalid is engaged in a momentous undertaking of infinitely greater magnitude than the pursuit of business or indulgence in social enjoyment. Patients should be taught that the *period of treatment* is the vitally *important era* of their *existence*, and that no reasonable sacrifice is too great, provided progress toward recovery is thereby facilitated. They should be informed that the duration of the period of medical observation is necessarily prolonged and that, in the verbiage of the legal profession, "Time constitutes the essence of the proposition." It is usually well to acquaint invalids with the fact that their path may be beset with difficulties, and that the journey to recovery is attended by trials to their patience, endurance, and fortitude, but that the hardships are surmountable by dint of courage, wise guidance, and indomitable perseverance. In the effort to impress trifling young men with the gravity of the situation I sometimes have made use of the following homely illustration: "You are engaged in an arduous conflict with a most formidable antagonist. Your opponent is worthy of your most strenuous efforts, and will be quick to take advantage of the

slightest opening to inflict a serious blow. The struggle is no four- or six-round contest, but the fight is destined to continue to a finish. There can be no such thing as a draw. Either your enemy will be finally vanquished or pulmonary tuberculosis will have attained the victory over you. It is for you alone to decide whether you will enter the arena with a determination to succeed and with the exercise of eternal vigilance be prepared to withstand successfully the onslaughts of an unrelenting foe."

It is often expedient to inform the invalid concerning the signal advantage possessed by virtue of the natural powers of resistance to tuberculous infection. It is usually well to make clear that there is *no special method* of treatment, and that the position of the medical attendant is that of *counsellor*, to *guard against blunders* and *indiscretions*, and that strict compliance with instructions is a *sine qua non* to success. I have found it desirable in many instances to explain in a simple and concise way the manner in which the inherent constructive forces of the individual are capable of producing arrest. Among intelligent invalids I have found this of practical advantage in the stimulation of renewed efforts, and in the reassurance conveyed as to the rationale of the treatment. Words to the following effect have usually been found satisfactory for this purpose. "Any injury to the surface of the body attended by a loss of substance is followed by the formation of new connective tissue, which differs markedly in structure from the adjacent parts. The scar tissue which results is dense, tough, fibrous, and contractile. The formation of this tissue, which has no analogue in health, is nature's method of repairing damage in the various organs and soft parts of the body. Consumption is a disease produced by a certain microörganism, which, upon gaining entrance to the lungs, incites characteristic tissue change. Tiny elementary tubercles are formed, several of which become confluent and unite to produce definite nodules. One of the essential characteristics of these tubercles is the tendency toward central degeneration, caseation, and disintegration. As this takes place, the process of repair becomes established in varying degree in different individuals. The two processes continue simultaneously, and a race is established between *tissue destruction* and *tissue construction*. If in your fight with tuberculosis you possess sufficient vitality to manufacture new tissue more rapidly than the lung tissue is destroyed, you win. If, on the other hand, your efforts toward the making of scar tissue are enfeebled, the reverse is inevitable. The measure of your constructive capacity is the conservation of strength, which to a great extent is to be proportionate to your gain in weight and your rigid economy in the expenditure of bodily energy. To secure satisfactory results in your struggle with tuberculosis, it is necessary to attain a surplus of vital energy through the influence of nutrition. This is accomplished as a joint result of superalimentation and physical rest. It is not altogether what you *earn* through enforced feeding, but also what you *save* by being quiet."

As a result of this personal understanding of the rationale of the methods to be advised, it is easy to conceive how much more ready is the acceptance of an enforced régime, how much greater confidence is established between patient and physician, and to what greater extent there may be instituted mutual sympathetic coöperation. Thus, having instituted early relations of confidence and reciprocal effort, the

physician is usually permitted with less opposition to elaborate ideas of treatment, which might otherwise be non-acceptable to patient and friends. In maintaining a responsible direction of the patient, the clinician is repeatedly confronted by the necessity of observing a diligent, painstaking regard for detail.

It is comparatively simple to prescribe rest, fresh air, and plenty of good food, but the obligation of the physician is not discharged until he *personally provides such accommodations* as will insure the proper continuous execution of his directions. The surroundings of the patient should be subjected to personal inspection, simple inquiry relative to the environment being utterly inadequate for the determination of its fitness. Accurate information must be secured as to the appropriateness of the location, the adaptability of the dwelling to the purposes and needs of the patient, the character of the food, and the nature of social or recreative features. Attention should be specifically directed to the occupation, habits, financial status, domestic relations, resources for individual entertainment or diversion, and finally to the disposition and degree of self-control. The management of consumptives is radically different from that of any other class of human beings, in view of the fact that, by virtue of their illness, there are sometimes exhibited decided changes of temperament and mental attitude, as described in connection with the General Symptomatology. Pulmonary invalids constitute a class decidedly unique and peculiar to themselves, demanding of the medical attendant the exercise of the greatest tact, judgment, and skill that is required in all the domain of medicine.

It unfortunately happens in many cases that the accompanying members of the family exhibit traits of character and disposition which add vastly to the trials and vexations of the physician. While many patients have literally committed suicide through their own folly and indiscretions, others are sacrificed through the perversity, ignorance, and delusions of their immediate relations. Petting, sympathy, condolence, or indulgence on the part of others constitutes a most serious hindrance to the accomplishment of best results. For these reasons conspicuous success often attends complete segregation of the patient. Several times I have insisted upon the separation of little children from their parents for over two years at a time, and have placed them under the care of trained nurses especially adapted to the work. While this may seem difficult of execution, I have found that, if properly presented, the family are usually quick to appreciate the wisdom of such advice and govern themselves accordingly.

At no age are patients more domineering, wilful, and difficult of management than in the neighborhood of eighteen, even if confined to the bed. I have found the care of such patients to be made conspicuously more simple and effective if removed from their parents. The separation of husband and wife is often expedient by reason of various widely differing considerations in individual cases. In such instances the physician must possess the courage of his convictions sufficiently to insist upon the removal of these influences through such isolation as may be reasonable and practicable.

The task of enforcing a proper régime varies within wide limits. It is comparatively easy to secure the active coöperation of patients who are intelligent, phlegmatic in temperament, and amenable to advice, but it is the experience of those who are brought in contact with the vari-

ous stages and conditions of pulmonary tuberculosis that all patients do not conform to this class. When to the care of the pulmonary invalid there are added the difficulties arising from the peculiarities and perversions of judgment of members of the family, it is easy to appreciate that successful management necessitates such a degree of patience, determination, and attention to detail as almost to constitute a form of genius. The extent to which this endowment is possessed by the medical attendant is responsible in large measure for the success which may be expected to attend his efforts.

CHAPTER XCI

ADJUSTMENT OF PHYSICAL AND NERVOUS EFFORT

THE regulation of exertion constitutes a cardinal principle of treatment, applicable to all cases of tuberculosis. The processes of repair in general are stimulated by the enforcement of appropriate rest. For the accomplishment of best results it is imperative to minimize the demands upon the nervous forces, as well as upon the physical strength. *Conservation of energy* in every conceivable manner should be the watchword imparted to the patient, without which the onward progress toward recovery is interrupted by the interposition of serious, if not insurmountable, obstacles.

Rest for pulmonary invalids must be accepted as a purely relative term, varying in its interpretation from absolute immobilization in the recumbent position to moderate degrees of physical exercise. The important desideratum is the avoidance of *fatigue* from any cause, whether physical, nervous, or mental. Fatigue necessarily develops at varying times, and in vastly differing degree, according to the condition of individual patients. A restrained physical activity, which in some persons constitutes comparative rest, may represent in others an unwarranted excess. In the same way reading, study, conversation, card-playing, knitting, embroidery, or other handiwork may offer healthful diverting occupation to some, but become acutely exhausting to others, through the entailed mental effort or nervous excitement.

Rest may be regarded as eminently desirable for pulmonary invalids as a class, but the paramount consideration relates to an accurate determination of the extent to which this should apply to individuals. The intelligent and effective regulation of the exertion appropriate for a given consumptive, though attended at times with the greatest difficulty, perhaps transcends in importance all other features of treatment. Fresh air and superalimentation have long been recognized as valuable therapeutic factors, but practical experience leads to the belief that the adjustment of physical and nervous effort is even more important.

While the necessity for judicious circumspection regarding exercise obtains even among incipient cases, the rôle of rest as a therapeutic measure of the first magnitude is especially emphasized in connection with far-advanced patients. Open air, which admittedly is indispensable to all stages and conditions of the disease, becomes in *desperate*

cases subordinate in importance to complete rest. Either one of these factors, with the sacrifice of the other, is of but slight value to such a class. No matter how many the hours out-of-doors, if attended by *fatigue*, each day must be summed up as a *failure*. In like manner the enforced consumption of a proper amount of food can avail but little if the nervous force required for the proper performance of digestion and assimilation is dissipated through the influence of undue exercise or excitement. Physical exertion must be forbidden, even to the slightest extent, among far-advanced consumptives, not only because it produces exhaustion and further deranges digestion, but also on account of its tendency to increase temperature elevation and to excite hemorrhage. During the active advance of the infection the digestive, circulatory, and respiratory functions become embarrassed more or less by the presence in the blood of toxins which, formed in excessive amount, give rise to the fever and other characteristic symptoms of sepsis. It is precisely at such times that the additional burden imposed by physical exertion upon already overtaxed functions is productive of most disastrous results. Fever, then, may be regarded in any stage of tuberculosis as an unfailing indication for a mandatory insistence upon complete rest.

By absolute rest is meant the actual relaxation of the patient in bed during the entire twenty-four hours. A temperature in the neighborhood of 102° F. at any hour of the day suggests the wisdom of maintaining the recumbent position for an indefinite period, the patient not being permitted to rise until the fever has materially abated. An afternoon temperature of 100° F. or thereabouts, despite the absence of fever earlier in the day, demands a decided restriction of physical effort. Under such circumstances it is expedient to enjoin complete rest in bed at least during the period of temperature elevation. If the fever recedes to normal during the early evening, it is sometimes well to allow the patient to sit up for a short time before retiring for the night.

In general, patients exhibiting a temperature of $99\frac{2}{5}$° F. at any time of the day should be forbidden to indulge in walking as a form of exercise, as in such cases the fever is frequently increased even by a short, slow walk. In this connection it is important to discriminate between a temporary elevation of temperature taken in the rectum shortly after exercise is concluded, and the fever which may appear after an interval of rest. It has been ascertained that a considerable physiologic rise of temperature in health may follow prolonged or unusually severe exercise, even moderate walking for a comparatively short time may produce a slight elevation of temperature, which completely recedes after a half-hour interval of physical repose. The susceptibility of pulmonary invalids to temporary elevations of temperature after walking is much greater than of healthy people. The fever reaction in such cases is not only more marked, but of longer duration, the rise of temperature frequently being sustained for many hours in spite of complete rest.

Much confusion regarding the effect of exercise upon the body heat may be avoided if the temperature be taken in the mouth *only after* a period of *rest*. A transitory fever shortly after exercise may be detected if the temperature is taken in the rectum, while no indication of its presence would be afforded by the oral record. After the lapse of a short interval of rest, the physiologic elevation of temperature, as indicated in

the rectum, is found to subside, while the fever of pathologic significance is recognized in the mouth and remains persistent for several hours. It thus appears that but slight practical importance attaches either to the oral or rectal temperature taken *immediately* after exercise, the former being fallacious and the latter ephemeral. The development of fever, as evidenced by the oral record, after rest is an undoubted indication of the immediate deleterious effect produced by physical effort. For such patients exercise should not be again permitted until the temperature has receded below 99° F. and remained practically normal for at least several days. When walking is resumed tentatively, the utmost caution should be taken to guard against overexertion. Upon the whole, fever may be regarded as the leading contraindication for physical exercise.

Complete rest in bed is also demanded in the presence of severe dyspnea and cyanosis, with a weak and rapid pulse. As a rule, circulatory or respiratory embarrassment does not suggest as emphatically as fever the imperative necessity for absolute rest. In such cases, without temperature elevation, the indications point to a considerable restriction of active physical effort with, sometimes, under competent supervision, the systematic employment of passive movements. Rubbing, gentle massage, or resistance exercise may be utilized occasionally to promote capillary dilatation, to equalize the circulation, and to develop the heart.

In less desperate cases, in which the maintenance of the recumbent position is not warranted, much good may be accomplished in selected cases by carefully adjusted exercise. It is essential, however, that the degree of physical activity should be subject to a judicious regulation and control. Through the increase of appetite, the promotion of oxidation and elimination, the general tone of the system is materially improved and resistance correspondingly increased. It should be insisted that muscular development is not the *end* to be achieved, and that exercise is of value only in proportion as *general resistance* is promoted. Patients should be informed that the accumulation of a reserve in nutrition and vital energy is of vastly more importance than muscular strength or powers of endurance. In selecting a form of exercise consistent with the needs of a given case, there is demanded of the physician far more than a consideration of the *physical condition*. A feature of no little significance is the psychic element, which may be taken advantage of through an intelligent inquiry regarding the tastes of the individual. By this means there may be afforded a wise discernment regarding the appropriateness and value of various forms of outdoor amusement. For the accomplishment of the most satisfying results in the continued maintenance of an outdoor régime, it is essential that *recreation* be *combined* with *exercise*. Natural and acquired proclivities of individuals should form within certain limits an important, if not a determining, factor in the character of the physical diversion permitted to pulmonary invalids. A measure of the usefulness of any outdoor pastime, provided that this is not subject to especial contraindications, and pursued in strict accordance with prescribed directions, is the degree of *actual enjoyment* afforded. Correctly regulated exercise, if adapted to the inclinations of the invalid, is diverting in nature and correspondingly healthful, while physical effort *without recreation*, no matter how perfectly adjusted, remains but *work*, and hence less advantageous.

Walking in the open air is the simplest, safest, and usually most

acceptable form of exercise for pulmonary invalids. This appears capable of an easy and accurate regulation, but such is not always the case. The paramount thought is to *avoid* the *slightest fatigue, shortness of breath,* or *cardiac palpitation.*

It is essential that the invalid should be permitted to resume a position of rest not after he has experienced fatigue, *but before.* He should not walk until he is tired and then attempt to return, but should arrive upon the porch before this sensation is felt. If *fatigue* is experienced as a result of the walk, and particularly if *persistent* after a rest of ten or fifteen minutes upon the couch, definite *harm* has been *inflicted.* While it is apparent theoretically that the duration of the walk, the direction, the time of day or night, and even the company should be definitely outlined by the physician, such a degree of supervision is not always practicable. Furthermore, the utmost difficulty attends anything like a correct estimate of the individual capabilities at different times. Invalids exhibit a decided variance in the effect produced by a fixed amount of exercise even upon successive days. The extent of the walk appropriate for the consumptive can be determined only by a comprehensive regard for much detailed data. While it is comparatively easy to prescribe perfunctorily the exact distance, the hour, the course, and even the pace, such a refinement of treatment savors more of ignorance and imposture than of clinical exactitude.

From a purely practical standpoint the conviction has been forced that while rigid supervisory guidance in the matter of exercise falls properly within the province of the physician, the detailed application of the principles of rest must be left to *some extent* to the *intelligence, obedience,* and *judgment* of the *patient.* The enforcement of a strict advisory régime should not necessarily imply that pulmonary invalids be compelled to resolve themselves into unthinking automatons whose very existence shall be controlled by autocratic dictation. After an elaboration of the principles upon which the determination of appropriate exercise is based, an appeal to the reason and understanding of the consumptive serves to establish relations of confidence and good feeling and, in addition, inspires the invalid with a sense of his personal responsibility. To intelligent invalids, devoted to the cause in which they are forced to enlist, the advisory direction should not partake of an arbitrary character. In view of the difficulty attending the accurate differentiation of individual capabilities and requirements, it not infrequently happens that the patient, even better than the medical adviser, is enabled to appreciate the effect of prescribed exercise, and to judge approximately concerning the propriety of its repetition. Many patients who have been suitably instructed concerning the dangers of overexertion, quickly recognize its deleterious effect, and learn to exercise a judicious regard for their own welfare in the matter of physical activity. The physician should insist upon comparative rest for all ambulant cases, and admonish earnestly that general directions in this respect be scrupulously obeyed. Definite commands well within the limits of safety must be issued to the ignorant, headstrong, and frivolous. Consumptives who are wilful or vicious are wont to disobey mandatory instructions, no matter how emphatically or definitely given.

It is highly essential that the beginning walk for convalescent invalids should be short, slow, and upon level ground. With increasing strength greater indulgence may be extended from time to time, pro-

vided no unfavorable effects are noted. In the interests of safety it is well to inculcate in the minds of patients the conviction, that exercise does *not constitute* an *especially important desideratum* in the effort to secure arrest, but rather represents an *indulgence* to be granted in *selected* cases with *wise discrimination*. Prolonged walks and arduous hill-climbing should be interdicted, even to patients well upon the road to recovery. In general issue is taken with the recommendation of graduated walks upon upward inclines, a practice, unfortunately, still somewhat in vogue. While this procedure in some instances produces beneficial effects in the development of the heart and improvement of the respiratory function, untoward results from such strenuous exertion are all too frequently noted. These consist not only of general fatigue, breathlessness, and cardiac palpitation, infallible criteria of the unfavorable effect of exercise, but also of the occasional intercurrence of pulmonary hemorrhage or pneumothorax.

The character of the pulse is often an important guide to the regulation of the walk. Marked rapidity, weakness, or irritability clearly indicate the necessity of continuous enforced rest. It is the custom of some internists to attempt a reduction in the pulse-rate through a graduated system of active methodic exercises. An experience in the higher altitudes leads to the belief that such measures, no matter how carefully conducted, are, as a rule, distinctly deleterious, and that overfrequency of the heart demands, in the majority of instances, insistence upon complete rest.

Patients who are considerably exhausted by disease usually become readily amenable to control as regards the extent and character of their physical exercise. With *beginning* subsidence of subjective symptoms a continued ready compliance with instructions is often manifested, but with returning strength, increase of vitality, and buoyancy of spirits an *overconfidence* in the physical capabilities and endurance is naturally engendered. At this time it is often exceedingly difficult to impress the patient with the fact that recovery has not yet taken place. The invalid should be made to realize that despite the complete disappearance of all clinical manifestations, an improved nutrition and the consciousness of physical strength, there still remain definite pathologic changes in the pulmonary tissues. Far from permitting the assumption that a cure has been permanently established, it is expedient to designate the condition as a quiescent tuberculous infection undergoing arrest. The further evolution of a complete enduring recovery is dependent largely upon the degree to which the patient conforms to wise counsels regarding conservation of strength. Even the physician at this stage is likely to deceive himself by a sense of false security, and, yielding to the blandishments and confident assertions of the patient, may permit a laxity in the supervisory control, seriously jeopardizing the interests of the apparently cured consumptive. There can be but little ultimate satisfaction to the physician in having his patient *improve* unless he succeeds in bringing about a *final arrest* of the tuberculous process. To this end no therapeutic measure is of more undoubted efficacy than a continued *economy in the expenditure of physical and nervous energy long after the disappearance of all clinical manifestations* of the disease.

An interesting and somewhat remarkable difference of opinion is entertained among medical observers with reference to the practical utility of pulmonary gymnastics. Some there are who advocate deep

breathing exercises as of striking therapeutic value, while others entirely discountenance such measures as fraught with definite elements of danger. Strikingly different arguments are advanced by those advocating and opposing pulmonary gymnastics for consumptives. The former assert that an underlying principle of treatment is exercise of the tuberculous lungs, in order to promote their expansion, circulation, and nutrition, thus adding to the aëration of the blood, the elimination of carbon dioxid, and the resistance of the entire organism. It is the contention of others that a cardinal feature to be observed is the maintenance of rest for the tuberculous lung, as well as of the tuberculous individual, in order to avoid an extension of the infection into new pulmonary areas, and to avert the development of pneumothorax or pulmonary hemorrhage through unusual activity and depth of the respiratory excursions. Clinical evidence is not lacking to sustain the claims of those entertaining views diametrically opposed to each other. The beneficial effects obtained in the higher altitudes afford a presumptive confirmation of the advantages derived from an increased activity of the respiratory function, although in such resorts *other factors* share in the production of favorable results. Upon the other hand, attention has been called in previous chapters to the not infrequent improvement noted during compression of lung by a moderate pleural effusion.

A review of the available data discloses the fact that an active expansion of affected pulmonary areas is of undoubted value in a large proportion of cases, that compression of affected lung is useful in others, but, above all, that *artificial* methods of producing either vesicular dilatation or compression are frequently attended by possibilities of danger. While their employment in some instances is followed by results of a gratifying nature, in others the effect is eminently injurious or of doubtful utility.

It is clear that the scope of pulmonary gymnastics is subject to considerable limitation, and that belief in their efficacy or harmfulness varies according to the environment, personal experience, and point of view of medical observers. It is apparent that if unfortunate consequences are to be avoided from the employment of deep breathing exercises, judicious discrimination must be exercised in their individual application. Pulmonary gymnastics are undoubtedly of decided benefit in the presence of certain non-tuberculous changes in the lung and pleura. It is important to distinguish clearly between the chronic anatomic conditions present in such cases and the acute pathologic processes incident to pulmonary tuberculosis. In the midst of extensive pleural thickening with marked fibroid change, incomplete expansion of lung following operation for empyema or pneumopyothorax, delayed or partial resolution following pneumonia, or pleuritic adhesions subsequent to an effusion, it is important to restore the respiratory function as fully as possible. The indications then point to the enforcement of vigorous breathing exercises in order to promote expansion of the already crippled lung, and incidentally to enhance the compensatory activity of the non-damaged pulmonary areas. There is no valid reason why the *existence of similar conditions* among tuberculous patients should not suggest the expediency of the same procedures, provided important contraindications do not exist. While routine recourse to the employment of pulmonary gymnastics for consumptives should be unquali-

fiedly condemned, carefully supervised breathing exercises have proved to be eminently beneficial in the partial restoration of the respiratory function resulting from the above-mentioned complications.

The practice of forcible breathing among *active advanced* cases offers but little if any advantage, and much in the way of disastrous results. Among the unfortunate sequelæ sometimes observed are the further extension of the tuberculous infection, the gradual production of general emphysema, the development of pneumothorax from rupture of pleura, the onset of pulmonary hemorrhage, and, rarely, an aspiration pneumonia. The practice of recommending deep breathing exercises to pulmonary invalids should be discredited whenever the subjective manifestations and physical signs portray an active or extensive tuberculous infection, especially if there exist acute inflammatory complications, pulmonary excavation, recurring hemorrhages, fever, irritable pulse, or exhaustion.

The advocates of pulmonary gymnastics have adopted various methods of putting deep breathing exercises into effect, with and without supplemental movement of the arms, changes of posture, and exercises of the body. Deep forcible respirations may be practised with the patient in the erect or reclining position and during the act of walking. It does not appear to be essential that the inspiration should be taken through the nose, as some have maintained, but it is important that the breath should be held for a few moments. The expiration, while not violent, should be as complete as possible in order to minimize the amount of residual air. Some aid is secured by bringing into play the voluntary muscles of expiration. To this end the arms may be raised to the horizontal position or over the head in inspiration, to be dropped quickly at the time of expiration. It is unwise to permit more than five or six deep respiratory excursions of this nature at one time, although in suitable cases they may be repeated several times during the day. Many instructors in physical exercise insist upon the backward movement of the arms until the dorsal surfaces of the hands touch each other in the back during inspiration, the arms being brought forward in expiration. At the time of inspiration, with or without supplemental arm movements, the body may be raised slightly upon the toes and held in that position as long as the breath is retained. The use of a breathing-tube is of no practical benefit, though in some instances possessing a slight moral effect.

It is important to bear in mind that the great majority of pulmonary invalids who are induced to seek medical counsel present sufficient evidence of active destructive lesions to contraindicate the employment of pulmonary gymnastics. In the presence of less active tuberculous infection, with partial pulmonary incapacity through subacute or chronic pathologic changes, the utility of such measures cannot be denied. Under these conditions it has been my custom to make occasional use of deep breathing exercises in Colorado, but, owing to the compulsory increase of respiratory activity at high altitudes, the practice has not been permitted unless very strong indications for its employment are presented.

CHAPTER XCII

ENFORCEMENT OF AN OPEN-AIR EXISTENCE

It is impossible to overestimate the importance of fresh air as an essential factor in the treatment of pulmonary tuberculosis. In reality, an out-of-door existence is an indispensable feature of modern phthisiotherapy. Upon this all medical observers are of a single mind, but, unfortunately, radical differences of opinion exist as to what constitutes the desirable qualities of inspired air. Purity and freshness of air, attributes unanimously conceded to be invaluable, are regarded by some as the *only important* considerations. The inhalation of an atmosphere carrying a proper amount of oxygen and devoid of injurious contamination is asserted by some to be productive of the fullest possibilities of improvement. Irrespective of other qualities of atmosphere and of the environment, fresh air, in its influence upon the course of tuberculosis, is proclaimed by these observers to be the same wherever found. Regardless of such essential features of climate as dryness, temperature, sunshine, altitude, atmospheric pressure, and wind movement, with their known modifying effects upon the respiration, circulation, digestion, skin, nervous system, and the general tone of the organism, the contention is inconceivably made that the sole desideratum is the inhalation of oxygenated air. Thus it has been announced broadcast that quite as good results may be obtained in one place as in another, provided the air is pure and fresh. This fallacious doctrine has been preached with a devotion and fanaticism worthy of a truer cause by many who should recognize the folly of subscribing to such an article of faith. In pursuance of this delusion, the dictum has gone forth that fresh air suited to the needs of the consumptive may be secured in the large cities as well as in the country, at the seashore as well as in the mountains, in damp marshy regions as well as upon dry sandy soil, and in a district characterized by fog, cloud, and rain as well as in the land of almost perpetual sunshine. It is not designed at this time to encroach even briefly upon the merits of the various climatic attributes in the treatment of consumption, a subject reserved for future discussion, but it is desirable *en passant* to denounce emphatically the false notions often entertained with reference to the rôle of fresh air, *exclusive* of all other modifying conditions of atmosphere and environment.

Even should it be assumed, however, that fresh air is but fresh air in any locality, decided issue must still be taken with the teaching that this feature constitutes the all in all of an outdoor existence. It matters greatly whether the air is obtained in the alleys and back yards, upon the house-tops and fire-escapes, and in densely populated districts or in properly constructed porches, shacks, or tents in the open country. Further, a factor of no little importance relates to the manner in which, through details of arrangement, fresh air is provided for the pulmonary invalid. The practical benefits to be derived from exposure to outdoor air are enhanced or lessened according to the opportunities afforded for the acquirement of an environment adapted to the individual. No principle of treatment throughout the long course of pulmonary tuberculosis is established more conclusively, than the necessity of rendering

the consumptive *comfortable physically*, and of inspiring a cheerful mental attitude through the influence of *pleasant, properly supervised surroundings.*

It is essential that phthisical patients should spend not merely a brief portion of the day out-of-doors, but should *remain* in the open air as many hours out of the entire twenty-four as weather conditions will permit. It is far from sufficient to advise the invalid to stay out-of-doors as much as possible. If left to the exercise of his own judgment and inclinations, the period of fresh-air existence is lamentably short, and usually accompanied by unfortunate indiscretions in the way of physical exertion. For consumptives to obtain fresh air at all hours, and at the same time to remain completely at rest, it follows that, in addition to definite *instructions* of such a nature, special *provision* must be made for this purpose.

The requirements to be observed relate—(1) to devices for securing the maximum amount of fresh air with the invalid at rest within doors; and (2) to arrangements for the comfort and shelter of the patient if in the open air. No matter how spacious the indoor apartments, how perfect the ventilation, how flooded with sunshine, nor how equipped for protection from drafts, there can exist no compensation for lack of outdoor accommodations. In case facilities for open-air existence are entirely unavailable, and particularly when circumstances do not permit the occupancy of large, sunny, well-ventilated rooms, several ingenious methods have been presented to permit the inhalation of pure air. An arrangement known as the aërarium provides for the partial outward extension of a cot bed from an open window, the head and shoulders of the patient thus being in the open air, though protected by an awning outside the window. The sleeping-room in which reposes the body of the patient is kept measurably warm in cold weather by the interposition of a heavy curtain suspended from the lower portion of the raised lower window-sash and tucked around the body of the patient. The sides may be opened or closed at will, ventilation being secured through the lower and upper part of the aërarium, the roof of which is double and provided with an opening. Another contrivance of more doubtful utility is the conduction of air from the outside to the head of the patient in the sleeping room through a large flexible tube consisting of heavy cloth supported by a series of light but stiff rings. This arrangement, for obvious reasons, appears less practicable than resourceful.

The window-tent devised by Dr. S. A. Knopf embodies all the desirable features of the aërarium and obviates some of the disadvantages. The window-tent is virtually an inside awning, consisting of canvas stretched upon an iron frame attached to the lower half of the window, as shown in Fig. 131. The tent is designed to rest upon a single bed, and to inclose the upper portion of the patient's body, its height, length, and degree of curvature being necessarily dependent upon the dimensions of the window. In its construction the effort is made to provide fresh outdoor air which shall not be allowed to mix with the air in the room. In case there is but a single window, a measure of ventilation for the room is afforded by an air-space of about three inches between the top of the window-tent and the lower edge of the sash. This space may be reduced or closed entirely by lowering the window. It would appear that the access of fresh air rendered possible by this

method is much greater than obtains in lower berths of Pullman sleeping-cars, though the conditions are in some respects quite similar. With the upper berth made up and the curtains tightly drawn the traveler in the lower compartment occupies throughout his entire length a modified window-tent. The comparatively small window opening is practically offset by the forcible entrance of air incident to the rapid motion of the car, yet the air within this confined space, even during hot weather, when the windows are open, often becomes noticeably foul. It is apparent that a vitally important feature of the window-tent is the opportunity afforded for the egress of expired air by virtue of the proportionately large opening. An added factor is the small capacity of the inclosed tent, with its rounded upper surface facilitating the course of the air-current. In describing the ventilation of the window-tent Knopf states that the cold air enters at the bottom of the open space, describes a quarter circle, and makes its exit at the top, carrying with it the exhaled carbon

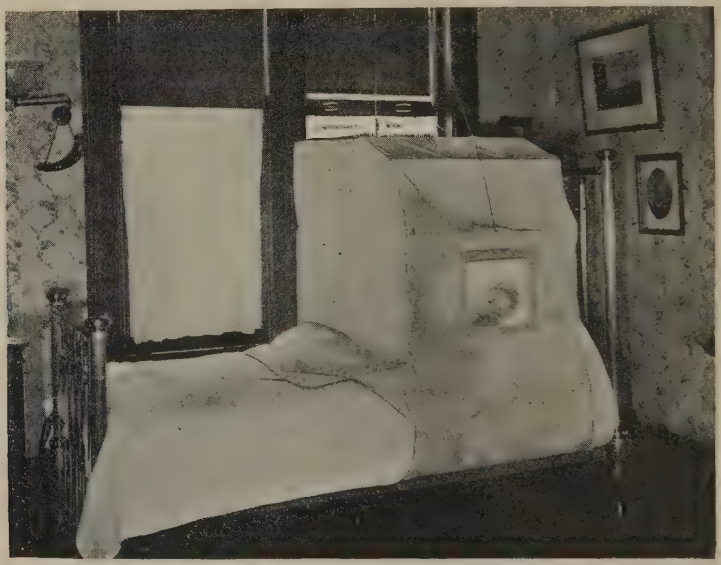


Fig. 131.—Dr. S. A. Knopf's window-tent.

dioxid. This I have verified by the use of a delicate instrument known as the air meter, the current being perceptibly inward at the bottom and outward at the top. In cold weather it is apparent that the outward direction of the air-current at the top is facilitated by the egress of heated air from the room through the aperture above the window-tent. This, of course, would not obtain during warm weather or when the window is brought down to the level of the canvas. It is also found that the degree of ventilation within the tent varies materially according to the direction of the wind and the temperature of the surrounding atmosphere: in other words, it is dependent somewhat upon the temperature relation of the inspired and expired air. The course and vigor of the air-current within the tent are greater in proportion as the temperature of the *exhaled* portion is *warmer* than that of the outside atmosphere. In cold weather the warm *expired* air rises to the upper portion of the tent and makes its exit in that region, its place being taken by the

entrance of cold air at the base. This is not true to an equal extent in warm weather, at which season an additional aid to the air movement seems particularly desirable. In the summer-time the window-tent is of less practical value than in winter, as opportunities for otherwise obtaining fresh air are usually ample. Moreover, unless a north window be utilized, the tent is converted into a veritable oven, the heat of the sun becoming well-nigh unbearable. Under such circumstances an outside awning, to afford protection from the summer heat, appears desirable. At any season of the year ventilation of the tent may be facilitated by the use of a small inexpensive fan propelled by air, and possibly by the insertion into the upper third of the window-frame of a piece of wood about one foot wide, slanting downward. A substitute for the window-tent has been devised by Dr. Charles Denison. This is known as the sleeping canopy and, like the preceding, is designed to provide fresh air to the consumptive who may be confined to the room. The canopy curtains are so arranged that they may descend from the upper portion of the window and encircle the exposed sides of the bed. At best, it is hard to conceive how the aërarium, window-tent, or other device for putting the patient at an open window can be productive of the very *best* results. While such ingenious arrangements are assuredly better than nothing, their disadvantages consist of the limited amount of fresh air capable of attainment, the obstacles in the way of special care and nursing on account of the hood arrangement, and the psychic influence, which hardly can be regarded as encouraging or inspiring.

Arrangements for the **comfort and shelter** of patients privileged to enjoy an outdoor existence are scarcely less important than the inhalation of pure fresh air. An essential feature in the acquirement of physical comfort for the outdoor consumptive relates to the adequate protection of *the body* despite low degrees of temperature. Coolness of air presents, as a general rule, no insuperable objection to the policy of staying out-of-doors at all hours. In fact, it has been my observation that more satisfactory results are often obtained during cold weather than during the summer months, unless patients are permitted to inspire the bracing air of the mountains at this time and experience the exhilarating effects of a new environment. Even when exposed to extremely low temperature, provided proper attention be given to the maintenance of body heat, patients are found to do extremely well in the open air, on account of the stimulation of the normal functions by the cold. It is, of course, important to avoid chilling of the surface of the body, but this may be prevented through the use of suitable clothing and, when necessary, by the application of hot-water bottles to the feet or about the body. It is desirable during the winter months that the patient should be kept moderately warm under all circumstances, but this does not imply the necessity of bundling up in heavy wraps, chamois-skin undergarments, and chest protectors to such an extent as to interfere with the proper function of the skin. The important desideratum is that the invalid be made comfortable through the use of proper apparel. Much harm may result from the wearing of clothing ill adapted to the state of the weather, frequent colds and physical debility ensuing from the burden, perspiration, and subsequent chilling occasioned by too heavy apparel. Patients should be taught that the actual utility of their undergarments is more dependent upon the fabric and construction than upon the weight.

In extremely cold weather moderately heavy woolen underclothing is

almost indispensable. In rigorous climates a double suit or a woolen chest protector, with an extra pair of socks, is sometimes necessary. The wearing of chamois-skin garments or of newspapers attached to the underclothing should be interdicted, on account of their imperviousness to air and the tendency to produce relaxation of the skin. Cotton garments or those made of outing flannel should not be worn next the skin in any season or in any locality. The cotton being a good conductor of heat, serves to promote radiation of animal heat from the body in cold weather, and to convey the overheated air directly to the body in summer. Its activity as a heat conductor is intensified by the retained moisture resulting from perspiration. In the milder climates and during less severe weather in cold regions, a light, loosely fitting woolen garment is preferable to the heavy skin-tight flannels so frequently worn. In very many instances the maximum of comfort may be obtained by the use of linen-mesh garments, which are light in weight, non-irritating, non-shrinking, and productive of no interference with the proper function of the skin.

In the matter of dress for the feet an important consideration relates to the avoidance of sweating. Socks should be of wool, but not too heavy, as perspiration is induced, especially by the use of old-fashioned knit stockings. When this takes place, an immediate change of socks, with vigorous rubbing of the feet, is desirable. The practice of inclosing the feet and ankles in heavy overshoes is less commendable than the use of stout, thick-soled shoes or felt boots. In extreme weather the feet may be kept warm by the use of a hot-water bottle and blanket.

The wearing of sweaters with a heavy roll tightly incircling the neck is more or less objectionable, as local perspiration is induced and the susceptibility to colds and sore throats increased. The same disadvantage obtains from inclosing the neck by a fur collar, save in the coldest weather. For the warmth of the ears it is much better to resort to the use of the time-honored ear-muffs than to employ scarfs or fur collars, unless demanded for the protection of the face.

At night, during the severity of the winter, the patient should sleep upon a double mattress, or a pair of woolen blankets should be placed next the spring, with another pair of blankets resting upon the mattress, in order to prevent the penetration of cold air from below the bed. In many instances a light woolen robe may be placed between the sheets, which the invalid, if desired, may wrap around the body. Consumptives often prefer to sleep in blankets with the body inclosed in woolen pajamas. In extreme weather sleeping-bags may be utilized, consisting of heavy woolen material, sometimes lined with fur or feathers, and buttoning closely around the neck and shoulders. It is important that the outer bed-clothing should not be too heavy, lest sleep may be disturbed to a considerable extent. Warmth is attained far more from the quality of the material used for bed-covering than from the weight. Old-fashioned quilts and comforters should be dispensed with whenever possible, and woolen blankets substituted in their place, while for the well-to-do eiderdown quilts are advantageous on account of their lightness. It is often desirable to protect the head with a light woolen night-cap, which may be drawn over the ears, leaving the face exposed. Protection is thus afforded to all portions of the body likely to suffer from exposure except the nose. Occasionally patients complain bitterly of the sensation of cold experienced at night at the very end of the nose. To

obviate this difficulty I have sometimes made use of a device suggested by Dr. James A. Hart, formerly of Colorado Springs, consisting of a piece of thick flannel or felt which is placed upon the nose and securely fastened by strips of rubber adhesive plaster extending horizontally upon the cheeks.

In addition to the protection of the *body* by means of proper clothing, it is important that *various means of outside shelter* be devised. During the summer provision should be made in all cases for protection from the intense heat of the sun and the sudden showers, and also means afforded for the avoidance of nervous irritation and loss of sleep produced by the ubiquitous fly or mosquito. In winter adequate shelter must be provided from the chilling blasts and protracted storm, indicating in no uncertain manner the violence of the elements at this time of year.

A superimposed roof of some kind is the first essential in the way of shelter for the tuberculous invalid in the open air. It is true that in Colorado, New Mexico, Arizona, and other comparatively arid regions the consumptive is often permitted to sleep in perfect safety under no other canopy than the starry skies, but a similar attempt in less favored regions, even in pleasant weather, is not to be regarded as an ideal conservative practice.

Next to the roof, the most desirable feature of an outdoor abode for the invalid is the presence of at least two protecting contiguous walls. These are required to give proper shelter in the event of storm or wind, at which times the bed may be moved into the sheltered corner, beyond the reach of snow and rain. A third wall is by no means indispensable, though sometimes of signal advantage in inclement weather. Opportunity to inclose temporarily the air-space upon the third side, and to remove subsequently the awning or screen at will is, therefore, a feature of added value. In order to afford satisfactory ventilation, it is absolutely necessary that the front or remaining side be kept entirely open.

Under all circumstances the floor should be of matched wood, entirely impervious to air, and raised a considerable distance from the ground. The front exposure should be toward the sun during a portion of the day, but it is not at all essential that it face the south. Means for ready communication with a nurse or attendant in case of need is a prime necessity.

Of further advantage is proximity to a commodious, well-heated apartment, into which the bed may be moved at any time. This not only permits the removal of the patient into the house during unpleasant weather, but also secures the privacy of the sleeping-room for bathing purposes, as well as greatly facilitating toilet arrangements. Another advantage of no little value consists of the easy accessibility of the kitchen, refrigerator, and pantry, enabling the invalid to receive food in appetizing form. Lighting arrangements are also greatly simplified by an immediate contiguity of the dwelling and the easy extension of electric wiring. Freedom from intrusion and protection from the stare of passers-by represent important desiderata to be secured by details of location and construction. Protection from the glare of the sun by means of easily adjusted screens, and from the annoyance of insects through the generous use of wire netting, is an added feature of comfort and utility.

From the foregoing considerations it is at once apparent that all the detailed advantageous conditions can be supplied only by *special provision* for *porch* accommodations. The second-story veranda as above described is undoubtedly the *ideal* arrangement for an open-air existence of the pulmonary invalid, but, unfortunately, this plan is not within the reach of all sufferers from consumption. Numerous methods have been devised looking toward the acquirement of fresh air at a modicum of expense. Several of these contrivances have been capable of application at certain seasons of the year, but have failed dismally at other times. Some have succeeded, to be sure, in offering to the consumptive a sufficient amount of fresh air, but at the expense of a large measure of his physical comfort and peace of mind. At other times the invalid, if rendered comparatively comfortable, is necessarily deprived, to some extent, of the very air which is so strenuously sought.

Tent life, ardently advocated by some observers, is open to many unavoidable objections. It is manifestly difficult or impossible by the use of tents to supply the required conditions already described as constituting an ideal arrangement. The tent occupant is necessarily near the ground for a prolonged period, and save in favorable climates, is exposed to a considerable degree of dampness, which is enormously increased in wet weather. In addition to the inevitable inconvenience and deprivation, there is much difficulty in cooler weather in securing physical comfort combined with proper ventilation. No matter how modern the effort toward sufficient ventilation, tents are usually cold in winter, if not overheated at the expense of fresh air, and often extremely oppressive in summer unless open to direct drafts. It thus happens that recourse to tent life, without special supervision as to details of construction and mode of habitation, is attended by results woefully disastrous to the unsuspecting invalid, deluded with the belief that "roughing it" is a panacea for tuberculosis. Rainproof canvas is, of course, air-proof as well, and while of little value in excluding the cold, serves effectually to *keep out fresh air*. In cold or boisterous weather the occupant is of necessity compelled to remain in a small, improperly heated, and poorly ventilated air-space, harassed meanwhile by the continual flapping of the canvas and the spasmodic tugging of the guy ropes.

Numerous attempts have been made to remedy the glaring defects common to the ordinary tent of former years. Important improvements have been embodied in the Gardiner, Tucker, and Fisher tents, the two former being employed somewhat extensively. The Gardiner tent, devised by Dr. C. F. Gardiner, of Colorado Springs, consists of a hexagonal wooden frame without center pole, but with vertical sides and conic top. The canvas is stretched over the framework and fastened to a raised board floor, thus dispensing with the necessity of stakes or guy ropes. Air is allowed to enter at the bottom and around the lower edges, exit being provided at the conic top, through which a stovepipe may emerge if desired. The sides may be turned back or kept tightly laced, according to weather conditions. The Tucker and Fisher tents also afford excellent ventilation facilities, but the expense in each instance is considerable and, upon the whole, the results attained less satisfactory than can be secured from the erection of other varieties of sleeping structures at a diminished cost.

While it has been my practice, as a general rule, to oppose the occu-

pancy of tents by my patients, fairly gratifying results in recent summers have attended the use of tents in the mountains by small colonies of invalids in straightened circumstances. The form of tent usually employed, for which no originality is claimed, but which subserves all practical purposes better than any other model I have observed, is shown in the accompanying illustration (Fig. 132). The important features consist of its comparatively slight expense, its large size, the dimensions being 12 by 14 with a height of 10 feet, the tightly matched wooden floor raised considerably from the ground, the vertical wooden sides to a distance of three feet, the upper portion of the sides consisting of canvas upon adjustable frames, the extension of the top well beyond the sides of the tent, thus effectually excluding the rain without the air, the use of the double top or fly thus minimizing the heat to a perceptible degree, the sliding shade insuring privacy at night without obstructing the entrance of fresh air, and finally the canopy of large meshed

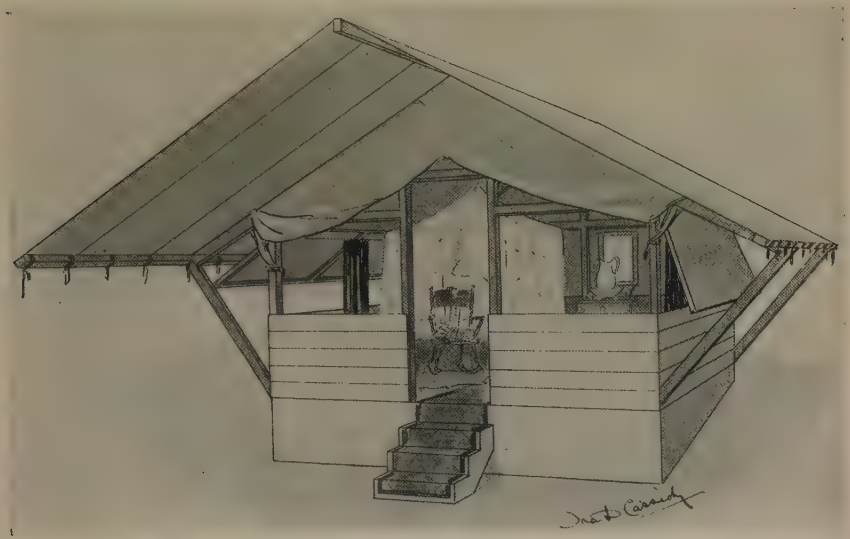


Fig. 132.—Inexpensive tent adapted for the use of pulmonary invalids during the summer months.

fly netting over the bed. It is easy to understand that during the summer months the erection of fifteen or twenty similarly constructed tents upon high, dry and sloping ground in close proximity to an establishment, containing an excellent dining-room, is of vast benefit to a class of pulmonary invalids. Another form of tent appropriate for occupancy during the warm weather is shown in Fig. 133.

Various forms of **wooden shelters** for consumptives have been designed from time to time, all based upon the same principle as a somewhat elevated porch. Among the desirable features embraced by these contrivances are cheapness of construction, protection from the elements by an overhanging roof and an inclosure upon three sides, abundance of fresh air, and in some instances communication with an adjoining inside room with heating and toilet facilities. A disadvantage of an enforced recourse to such improvised accommodations relates to the depressing effect upon the patients from the crudeness of con-

struction, and the frequent uninviting environment. Other drawbacks to their practical efficacy for advanced cases consist of inaccessibility

Fig. 133.—Cheap, but comfortable, tent for summer use.

Fig. 134.—Summer shack for sleeping and housekeeping purposes.

to the dwelling, remoteness of the kitchen, and consequent difficulty in serving properly prepared food, the frequent absence of nurse or

attendant, especially at night, and a location, as a rule, too near the ground, which becomes wet and damp in unfavorable weather. However, these wooden structures, notably Millet's sleeping shack and King's

Fig. 135.—Another shack similar to the preceding.

lean-to, are eminently useful devices, far superior to any form of tent in cold weather, and appropriate for a large number of patients. The

Fig. 136.—Shack appropriate for warm weather.

sleeping shack is, in effect, a porch severed from all communication with the house, thus entailing certain disadvantages, as described.

It is my custom to obviate these objections during the summer months by providing in the mountains, for a class of patients, shacks

that are suitable not only for sleeping, but for *housekeeping* purposes. These are inexpensive, but perfectly comfortable and well adapted to small families. A view of these somewhat primitive but none the less inviting abodes secured at a minimum of expense is shown in the accompanying photographs.

The lean-to arrangement, as developed by Dr. King, of Loomis Sanatorium, is virtually a sleeping shack designed for the accommodation of from eight to sixteen people. A wide shed is erected with a projecting roof over an open front. The ends may be open or closed, according to the requirements imposed by weather conditions. The beds, which are placed in a row in the rear of the inclosure, facing the opening in front, are assured of sufficient protection from beating rain or snow. Space is afforded for reclining chairs between the foot of the bed and the front of the inclosure. Canvas curtains are suspended along the open

Fig. 137.—Double sleeping porch with eastern and southern exposures. This summer residence is provided with porches upon all sides save the north, which is protected by the rocky formation appearing in the background.

exposure, which is thus capable of being closed at certain times. The most recent modification of the original lean-to consists of the construction of a well-equipped dressing-, bath-, and toilet-room, and a spacious sitting-room connecting two separate apartments for sleeping purposes.

An ingenious, somewhat expensive, and rather impracticable device is the *revolving shelter*, so constructed that the support of the building is borne by wheels which traverse a circular iron rail around the base, with a pivot at the center. The only important principle invoked by the substitution of these structures for the ordinary sleeping shack, is the means afforded for avoiding more completely the chilling effect of wind and storm, as well as for securing, if desired, the greatest possible

amount of sunshine. The revolving shelter may be of any size, of either cheap or substantial construction, of nearly square or circular form, and equipped with sliding windows or adjustable sides. After some opportunities for observation relative to the utility of such a contrivance erected six or seven years ago, at a cost of $500, in connection with the Oakes Home in Denver, evidence has been lacking to justify its employment in favorable climates.

Upon the whole, it appears that, if more or less unfavorable accommodations are good for a class of people unable to secure anything else, a commodious, specially arranged porch opening directly from the sleeping-room upon the second floor is infinitely better for others.

Fig. 138.—City residence with ideal upper sleeping porch connected with bed-room. Sheathing at the base, wire screening, awnings, electric light.

So high a value is placed upon this arrangement that I frequently insist upon the construction of such porches even by patients who take houses under lease. The porches should be covered by a permanent roof, sheathed from the bottom a distance of three feet, with a wide sill, and inclosed with wire screening, as shown in the accompanying illustration (Fig. 137).

It has been advised by some that patients should remain directly exposed to the rays of the sun as many hours as possible, regardless of the season. To this principle I am opposed, as it may happen that a porch, comfortable in the morning, becomes almost unbearable in the afternoon, and vice versâ. My rule is to permit the patient to

remain in the direct rays of the sun only during such times as actual benefit is experienced, and to remove the invalid whenever discomfort supervenes. It is not altogether the varying degrees of heat from the sun's rays that produce beneficial results. At different times there is demanded a judicious exposure to direct sunshine or protection from the intense heat according to the state of the patient and conditions of weather.

I am not in sympathy with an application of the theory of outdoor sleeping at night regardless of other considerations. This practice, when advised with proper discrimination, is capable of producing

Fig. 139.—Another residence with appropriate sleeping porch.

inestimable benefit in the way of an improved appetite and digestion, with an increased feeling of *bien être*, but its routine adoption is followed in some instances by harmful results. It must not be forgotten that the patient at all times must be kept perfectly comfortable, as well as being supplied with fresh air. In extremes of weather comfort can be secured only by lowering the canvas curtains, and closing all outside apertures to such an extent as to preclude proper ventilation. During severe cold, patients not only are more comfortable in a bed-room with moderate heating facilities, but at the same time are afforded much better ventilation from one or two open windows, than is possible upon an outside porch with all curtains tightly closed. Further, it has been my

experience, save during the summer, that *some* patients do poorly when sleeping out-of-doors. An explanation is found in the varying degree of bronchial irritation coëxisting with the tuberculous infection. In so far as the bronchial element predominates, by just so far is the cough made more distressing and the general condition thereby less favorable through exposure to the cold air at night. During the winter months the therapeutic indication for cases of chronic bronchitis *per se* is not fresh air, but rather protection from drafts and exposure. It appears

Fig. 140.—Small city cottages for groups of patients. The upper sleeping porches do not appear in the picture.

consistent and wise to offer bronchitic patients suffering from complicating tuberculous processes, the same judicious consideration. While in many cases there is no direct relation between the extent of the tuberculous change and the amount of bronchial irritation, the fact remains that severe bronchial disturbance reacts decidedly to the disadvantage of the invalid. This is especially exhibited in the fatigue incident to the cough, and in the reflex vomiting after the ingestion of food, which materially interferes with nutrition.

CHAPTER XCIII

REGULATION OF DIET

The vast importance attaching to the diet of tuberculous invalids is demonstrated by the fact that nutrition is, to a very great extent, the measure of nature's constructive efforts toward an arrest of the disease. It is true that occasionally individuals develop tuberculosis

even when there is little if any loss of weight, and that others exhibit improvement despite a considerably impaired nutrition. For practical purposes, however, it may be assumed that improvement in the general condition and in the state of the tuberculous process is fairly commensurate with the gain in nutrition. Thus an increased weight within certain limits is to be regarded as a safe criterion of the tendency of the invalid toward restoration to health.

The first great proposition, therefore, is to so improve digestion and assimilation as to permit a substantial increase of nutrition. Radical differences of opinion exist, however, among phthisiotherapeutists as to the degree to which efforts should be made toward the promotion of body weight. It is, of course, apparent that the greatest success will result in individual instances from the attainment of such a standard of nutrition as corresponds most closely with health, and produces the greatest powers of resistance. It sometimes happens that the tone of the general health is not improved by excessive gain in weight, with the attendant disturbance of digestive capacity and cardiac function. The increased nutrition may be associated with impairment of metabolism and the development of functional changes characteristic of pathologic obesity. It is under such circumstances that tuberculous infection secures a foothold among the very corpulent. It is often impossible to state with accuracy just when a sufficient improvement of nutrition has taken place, as the progress of arrest may become retarded as a result of indiscriminate "stuffing." While due caution should be exercised to avoid a predominating aim toward the accumulation of a disproportionate amount of fat, the comparative possibilities of producing such pathologic condition are few, and the dangers, save in exceptional instances, considerably exaggerated. Provision, therefore, for a generous and sustaining dietary becomes not only sane and rational, but indeed absolutely essential.

No matter how rigid the régime in other respects, nor to what degree the strength of the invalid is conserved by judicious rest, nutrition must remain largely dependent upon the ingestion of food sufficient to supply the natural demands, and aid directly in the reparative process. Much obscurity still continues to inshroud the proper detailed application of important principles of diet for the tuberculous invalid. In the midst of the widely differing conditions so frequently worthy of special consideration, even in early cases, and the ever-varying complications incident to advanced stages, definite information is often lacking with reference to the precise amount and character of food best adapted to the promotion of nutrition. Many conflicting notions have long been entertained relative to this vital consideration. It was not many years ago that consumptives were advised to imbibe generous, if not inordinate, quantities of whisky. The ingestion of an almost unlimited amount of food has been urged from time to time. By some the frequent use of lean meat has been strongly recommended and by others enjoined altogether. Conflicting ideas have been entertained as to the relative value of the various vegetable products, leguminous articles being held in much repute by some and considered of slight utility, if not objectionable, by others. A high estimate is placed by a great many observers upon the value of raw eggs, milk, cream, and beef-juice; while nuts, vegetable juices, meat-powders, extracts, and similar preparations are vaunted by a few.

Until a comparatively recent period, emphatic insistence was made upon the necessity of an *elaborate system* of superalimentation. It followed that in the attempt to carry out the principles of excessive feeding, the physician frequently failed to take cognizance of important modifying conditions inherent to individual cases. In numerous instances a highly injudicious stuffing process was inaugurated by physicians endowed with more energy and enthusiasm than with scientific instincts. Notwithstanding the existence of fever, digestive disturbances, and repugnance at the thought of eating, instructions were issued to pulmonary invalids to partake daily of a most extraordinary quantity of food, regardless of its capability as a producer of heat-units, or of its adaptability to the peculiar needs of special cases. Too frequently the quantity of the food, its selection as regards the nutritive value, and its appropriateness in the presence of functional disorders was left entirely to the tastes and inclinations of the patient.

As opposed to the previous superficial practice of extreme engorgement, with its distinctly deleterious results, there is exhibited at present a tendency toward mathematic precision in conformity with a fixed standard of diet, representing, upon the whole, a somewhat impracticable refinement of therapy. It is obvious that, through careful attention to detail, the amount and character of the food may be so regulated that general dietary principles may be formulated, which are susceptible of modified individual application.

It is clear, from a physiologic point of view, that the value of any general system of feeding to be accepted as an approximate standard of dietetics for pulmonary invalids must be dependent upon the relative caloric value of the various food-stuffs ingested. While nutrition varies directly according to the heat-producing properties of the *assimilated* or *metabolized* food, it must be borne in mind that the relative proportion of *ingested* fats, proteids, and carbohydrates per kilo of body weight bears no invariable relation to the nourishment of the individual. In other words, the caloric value of the food *eaten* by the patient is not always a criterion of the *caloric energy* imparted, through the processes of digestion and assimilation. In view of the numerous functional and organic changes common to pulmonary invalids, it is apparent that the dietary consideration of vital importance is not the definite quantity of the food, nor the relative proportion of the various ingredients, but rather the completeness of its subsequent assimilation, and the reduction of physiologic strain. Owing to the considerable variation of individual metabolism among consumptives and the degree of taxation imposed upon the powers of digestion and assimilation, the impracticability of an ideal standardized diet is appreciated. A definitely systematized diet, although theoretically ideal according to the principles of physiology, is utterly incapable of detailed practical application.

The observations of Voit, Chittenden, Folen, Atwater, Goodbody, Bardswell, Chapman, and others have been of decided interest and value. It has been estimated by Voit that from 30 to 35 calories per kilo of body weight are required daily to maintain good health in a normal adult while at rest, and about 40 calories if more or less active, representing in general 120 grams albumin, 50 grams of fat, and 500 grams of carbohydrates. These figures are more or less in accord with the statement of the late Sir Michael Foster, to the effect that the proportions

of food-stuffs consumed by healthy man were as follows: 100 to 130 grams albumin, 40 to 80 grams of fats, and 450 to 550 grams carbohydrates. Chittenden, however, has taken issue with these figures, maintaining that the amount of food ordinarily taken by a grown man in good health is materially less. The conclusions of Goodbody, Bardswell, and Chapman are to the effect that a diet properly adapted to a pulmonary invalid should contain 120 grams of albumin, 140 grams of fat, and 300 grams of carbohydrates. Burton Fanning has placed himself in accord with the above conclusions in indorsing the expediency of a substantial increase of fats and a corresponding diminution of carbohydrates for phthisical patients. In this country a number of observers have insisted upon a slight increase of the albumin, with a great addition to the fats and a diminution of one-half of the carbohydrates. It is generally believed that the equivalent of about 2200 or 2300 calories for a healthy man at rest, or of about 2700 or 2800 calories when at work, should be increased approximately to 3500 or 5000 calories for the pulmonary invalid, according to the state of digestion and the demonstrable effect of the diet upon body weight. It is known, however, that satisfactory results are sometimes attained among consumptives upon the daily ingestion of not over 25 calories per kilo of body weight, while failure to increase nutrition may result from the consumption of double this amount. Remarkable gains in weight may occasionally follow the ingestion of a phenomenal number of calories daily, sometimes approaching even 100 per kilo, but it is the opinion of Goodbody, Bardswell, and Chapman that such overfeeding, rather than increasing the powers of resistance, exerts a highly deleterious effect.

The conclusions of Chittenden as to the evil consequences resulting from an excessive consumption of albumin have been ascribed by Fisher to obtain similarly among pulmonary invalids. The latter observer assumes, on the basis of "physiologic economy," that with proper selection of food, embodying a certain proportion of fat elements, 3000 calories a day is ample for the nourishment of the average consumptive, although this is admitted to be no more than the amount consumed by a healthy person.

It is important to point out that although the principle of physiologic economy is sound for normal individuals, it does *not follow*, by any means, that the *essential consideration* among pulmonary invalids consists of making the *slightest possible demands* upon the digestive and eliminative apparatus, nor of giving the *least amount of food necessary to maintain body weight*. Under such circumstances the question properly resolves itself into a choice of the lesser of two evils. The decision must be made between a gratifying *increase of nutrition*, with corresponding *enhancement of resisting power*, even at the expense of a temporary tax upon physiologic functions, or an economy of functional demands, with the *unnecessary sacrifice* of a large portion of the *means of defense* against an insidious and relentless disease. In the presence of a wasting affection, the obligation is assuredly imperative to promote the powers of resistance through prompt recourse to vigorous, though rational, superalimentation. In general it is essential that the patient should take daily all that it is possible to administer *within* the *limits* of *digestion* and *assimilation*. The word "administer" is used advisedly. It is not what the patient *desires* to satisfy the cravings of hunger, it is not what he is willing to

take or even what he feels personally he is able to eat, but, after *careful inquiry* as to the *digestive capacity*, it is all that the physician and nurse are able to persuade him to ingest through their personal influence and direction.

The system of superalimentation is subject to great variation, according to the individual, principles appropriate for one class being entirely inapplicable to another. The very greatest importance attaches to the enjoyment of a good appetite and digestion. Under these conditions it is quite unnecessary, for practical purposes, to institute any elaborate system pertaining to the adjustment of the dietary. A generous mixed diet in such cases, without special reference to the relative proportion of proteids, fats, and carbohydrates, is usually all sufficient. It must not be assumed, however, that in the presence of a normal appetite and an unimpaired digestive capacity, the amount of food should be regulated entirely by the inclinations of the patient. The powers of digestion are often greatly in *excess* of the *indications afforded by the appetite.* Therefore, under a properly directed system of superalimentation much larger quantities of food may be consumed than suggested by the natural desires of the patient. The processes of absorption and assimilation are often promoted upon moderate forced feeding, with resulting gain of appetite and weight. The stomach is found to respond astonishingly to the increased demands, and it would appear that, with the assumption of greater functional responsibilities, the powers of digestion may be reinforced to a great extent. Clinical observation, at least, confirms the statement that, in many cases, the appetite and digestion are notably improved upon the adoption of an intelligent effort toward superalimentation. This is particularly true among invalids with a pronounced diminution of resistance resulting from a previous restriction of diet. It is probable that the subsequent general improvement is contributory in part to the gain in the digestive function.

There should be recognized the necessity of important modifications of the principle of overfeeding, even though appetite and digestion remain apparently unimpaired. It is manifestly improper to urge the ingestion of an inordinate amount of food after the loss of weight has been satisfactorily overcome. With increasing gain in nutrition, particularly if this is in excess of the normal, greater caution must be exercised. It must not be assumed, however, that because the invalid has surpassed his previous maximum weight, the necessity for generous alimentation has ceased to exist. The indications for cessation of overfeeding are not dependent altogether upon the gain in body weight, but also upon the state of the digestion and circulation, and the degree of improvement noted in the pulmonary condition. Patients who are loath to engage in an effort to improve nutrition, should nevertheless be encouraged to persevere cautiously with a generous dietary, particularly when the weight continues disproportionately light in comparison with the height and when at variance with family characteristics.

It is important in all cases to consider carefully the tastes of the patient, the variety and character of the food, the manner of cooking, and the style in which it is served. Through the power of suggestion by the nurse or attendant, coupled with the exercise of extreme care in the preparation of the food, patients are frequently enabled to overcome their natural repugnance for certain articles.

In perfecting a system of superalimentation, much depends upon

the habits and customs of the individual in respect to the nature and variety of food. It is often difficult to develop the habit of partaking generously of meat among those previously unaccustomed to its consumption. In the same way patients, as a rule, do not incline favorably to the ingestion of fats and carbohydrates, provided this has not been in accordance with former habits. In various parts of the United States marked differences exist as to the manner of food preparation. In health resorts, patients from widely remote localities are observed to be exceedingly susceptible to radical changes in food selection and method of cooking. Under such circumstances it is the height of folly to ignore the logic of previous habits, and resort to coercive measures in an effort to secure the ingestion of sufficient food. Whenever possible an effort should be made to cater to the peculiarly capricious appetite of the pulmonary invalid, as viands unappetizing to some are found savory and delectable to others.

Appetite and digestion are materially aided by the attractiveness of the food and the daintiness with which it is served. Cleanliness of dishes and linen, and absence of food remnants are important considerations. Patients should not be permitted to partake of their meals when exhausted from physical exercise, or during a state of mental or nervous excitement. At such times rest before the meal is imperatively indicated. In many instances patients do far better if permitted to eat by themselves, thus avoiding the confusion and excitement incident to the presence of members of the family or other pulmonary invalids. In some cases, however, a greater amount of food is ingested if invalids are privileged to enjoy a pleasant, non-exciting social atmosphere at mealtime.

Aside from these well-recognized principles the degree of success attained in the effort toward heroic feeding depends largely upon the personal influence of the nurse. The physician may emphasize ever so clearly the necessity of overfeeding, and invalids, in appreciation of this, may recognize full well that a large measure of the responsibility rests directly upon themselves, yet it may happen, from various causes, that they are unable to take unaided a proper quantity of food. Depression of spirits, temporary excitement, or fatigue, with weakened willpower, may suffice to render the meal a failure. It is here that the usefulness of the trained nurse is very apparent. Through the various means at her command, according to tactful judgment and the exigencies of the case, she should be able to exercise an influence which may often turn failure into success. Her power may consist of quiet persuasion, exhortation, or command, but the result is the same in any instance. The attendant should be taught to employ all these measures when necessary, and failure to enforce the ingestion of a satisfactory meal should not be overlooked save in the presence of fever, acute digestive disturbance, or other equally sufficient cause.

A systematic endeavor must be made to determine the limit of tolerance for each individual, who should be compelled to consume a satisfactory quantity of food, not according to his own ideas, but as ascertained by judicious experiment and close clinical observation. It is remarkable to what an extent patients, who at first protested their utter inability to take more than a modicum of nourishment, are finally enabled to ingest a generous quantity of food.

The conclusion is logical that the obligation of the physician to the

patient is not met by the formal perfunctory statement that it is necessary to eat large quantities of food, nor, still further, by specifying the amount to be taken. His trust is not discharged until the patient is placed in such an environment, and surrounded by such influences as will *secure compliance* with detailed instructions regarding the food. The attainment of successful results depends not alone upon the advice received by the patient, nor entirely upon his ready acquiescence, but rather upon the fortunate acquirement of such combined conditions as will *insure* the *actual fulfilment* of dietary directions.

It is hardly necessary to specify in detail the character of the food, which is necessarily subject to much variation in individual cases, the central thought being to have the patient consume as much as can be assimilated. It is well, however, to state briefly the considerations leading to selection of diet in the absence of acute conditions or digestive disturbance.

The policy of overfeeding embraces a careful supervision of the food eaten during the meal and the nourishment taken at other times. The fullest measure of success can be obtained only through a special effort toward the selection of such varied articles, as will appeal to the appetite and cater to the desires of patients who are admittedly whimsical. In the absence of digestive or eliminative conditions clearly contraindicative of heroic feeding, the patient should be urged to ingest progressively increasing quantities, being subjected at all times, however, to close clinical observation. Generally speaking, pulmonary invalids should be encouraged to partake of a mixed and unlimited diet, with instructions to use butter and cream freely. No attempt need be made to restrict the character or quantity of the food unless in accordance with special indications. It is desirable that the invalid should consume lean and fat meats, vegetables of all kinds, farinaceous articles of food, fruits, nuts, and generous quantities of milk and eggs.

For breakfast there may be given sliced oranges, grape-fruit, canteloupe, baked apple with cream, stewed prunes with cream, and other fruits in season; beef-steak, chops, chicken, soft-boiled eggs with bacon, eggs scrambled, poached, or in omelet, choice ham, or occasionally a well-prepared meat hash; buttered toast, hot rolls or muffins, corn or wheat cakes, and waffles; tea, coffee, or cocoa, and one or two glasses of milk.

Dinner may consist of raw oysters or clams; a well-seasoned soup, *i. e.*, vegetable, turtle, chicken, beef, mutton, or fish, purée, as a rule, being less desirable than consommé or broth. Fish of almost any kind, with potato and green peas, roast-beef, lamb or mutton, chicken, turkey, duck, or other varieties of game or birds, potato, baked, boiled, mashed, French fried, lyonnaise, or served in cream; spinach, string-beans, sweet corn, asparagus, squash, or other vegetables, in addition to macaroni prepared in various ways; lettuce, tomato, asparagus, or fruit salad prepared with a generous quantity of oil; crackers and cheese; rice custard or pudding, ice-cream, blanc-mange, or other light dessert; two glasses of milk.

Food partaken in the latter part of the day should be somewhat lighter in character and less in quantity than that constituting the midday meal. There may be served a steak or chop, cold roast-beef, lamb, tongue, boiled ham, chicken or turkey, fish and oysters prepared in various styles, potatoes, hashed brown, baked, or mashed; eggs in

any form; buttered toast, hot rolls, or muffins; fruit or berries with cream; tea and two glasses of milk.

As far as *extra* nourishment is concerned, it is desirable to introduce as much concentrated food as is practicable, with the least resulting impairment of appetite and disturbance of digestion. My practice is to administer from two to four ounces of beef-juice immediately upon awakening in the morning. This better enables the patient to undergo the bath, and does not interfere with the appetite for breakfast, which is served one hour later. The beef-juice is repeated in the middle of the forenoon, afternoon, and evening, and constitutes the only nourishment permitted between meals. Being of small bulk, it has not been found to impair the appetite for the ensuing luncheon or dinner. It has been my almost invariable experience that if considerable quantities of food in the shape of raw eggs and cream are taken between meals, the subsequent appetite is destroyed to a great extent. Thus the patient may be able to take in the twenty-four hours actually less food than if there had been no attempt in the way of extra nourishment. This unfortunate result rarely occurs if the eggs and cream are taken *immediately following* the meal. It must be made clear that extra nourishment should not be taken as a substitute for even a portion of the regular food, but should be entirely supplementary to it.

After the invalid has eaten all that can be comfortably consumed, it is surprising how simple is the ingestion of raw eggs and cream, and with what beneficent results, provided they are taken in the proper manner. The eggs should be swallowed whole with a little sherry, lemon-juice, or ice-water. In this manner they are introduced into the stomach without any special taste, and do not become repugnant to the patient already satiated by a generous meal. Difficult as the feat of taking raw eggs may at first be considered by the invalid, it speedily becomes an unobjectionable routine procedure. Under no circumstances are the eggs to be beaten or mixed with cream or milk. If incorporated into a palatable beverage, they eventually become distasteful and nauseating, while if without special flavor and swallowed quickly, they may be continued almost indefinitely. The average number of raw eggs at present consumed by my patients daily is from six to eight, but the necessity for careful individualization is very apparent. Immediately following the eggs, half a glass of cream is ingested. To some patients somatose in teaspoonful doses is given three times a day, either in soup or in the beef-juice. Often emulsions of easily digested fats are taken one-half hour after each meal. In very desperate cases it is my practice to take advantage of every opportunity for the administration of nutritive enemata, consisting of beef-juice, a beaten egg, and peptonized milk.

Alcohol, although admittedly a food, is permitted but sparingly, and then only in the presence of clear therapeutic indications. It rarely is given as a cardiac or general stimulant, save to people of advanced age. Used indiscriminately, it adds to arterial excitement, increases the tendency to hemorrhage, impairs appetite, and promotes restlessness and insomnia. The detection of its odor upon the breath or the flushing of the face may be regarded as a direct indication of its harmful effect. When used in sufficient quantity to destroy the appetite and retard digestion, the amount of food supplied by the alcohol is far less than the nutritive value of the food ordinarily taken. To the diminished

food-supply occasioned by the alcohol in inordinate amounts is added the distinctly injurious effect of overstimulation. Its intelligent administration, however, in small doses, and to carefully selected cases, may be attended by considerable benefit. It is sometimes well to permit those with fickle appetite to take a mild dry cocktail five or ten minutes before the midday or evening meal, but this should not be continued for any great length of time. If taken cold, only for such periods as advised by the physician, it may add to the consumption of food. A light ale, stout, or "half-and-half" consumed with the meals is of some value as an appetizer and an aid to nutrition. Taken during the evening, it is frequently found to promote sleep. Occasionally a sherry, Rhine wine, or Moselle may be served with the dinner. This constitutes the only manner of administration of alcohol which should be permitted, save in the presence of acute conditions demanding active stimulation.

CONTRAINDICATIONS FOR EXCESSIVE FEEDING

Important modifications of diet are demanded by the existence of marked temperature elevation and by the development of digestive or kidney disturbance.

Fever from any cause should constitute an insuperable objection to the general practice of superalimentation. The degree of restriction, however, is largely dependent upon the height and persistence of the fever, its immediate cause, and the varying associated conditions. A temperature elevation of 101° F. or more, irrespective of its source, is almost always accompanied by a perceptible diminution of appetite and impairment of digestive power. At such a time solid food administered in excess of the capacity for assimilation is worse than useless, often being productive of anorexia, pain, vomiting, intestinal flatulence, and diarrhea. In addition to such disturbances engendered by an injudicious diet in the presence of fever, an unnecessary burden is placed upon the entire digestive organism, resulting in occasional strain upon the heart, with acceleration of pulse.

It is believed by some clinicians that moderate fever in the neighborhood of 102° F. affords no especial contraindication for forced feeding. The contention is even made that under such circumstances the amount of solid food should at once be reinforced, in the hope of improving the general condition through increased nutrition. Such practice is based upon the assumption that gain in weight constitutes an important factor in the control of an obstinate pyrexia by virtue of the added resistance to toxins, which is supposed to accrue from improved nutrition. Apparently the advocates of a full dietary for fever patients, in the hope of thereby overcoming excessive temperature elevation, do not take sufficient cognizance of the fact that the digestive functions are greatly impaired by the very toxin responsible for the fever. Thus, upon the merits of the defective assimilation, the logical demand is for less rather than for more food. The food requirements of such patients are better satisfied by the ingestion of only such quantities and varieties as are capable of complete metabolism. Further, it should be understood that the preëminent desideratum *under such conditions* is not the *immediate* improvement of nutrition, but the *primary reduction of fever*. For the latter purpose other agencies are

available of far greater value than even a successful effort to increase weight.

The influence of rest, fresh air, and specific medication in the abatement of fever are elsewhere described. In this connection the relation of food and fever is to be considered not upon the basis of a theoretic assumption concerning the possible reduction of temperature through a large dietary, but rather is to be reviewed from a practical regard for the known inhibitory action of fever upon digestion and assimilation. In other words, experience has taught a more wholesome respect for the unfavorable influence of fever upon food metabolism than for the beneficial effect of superalimentation upon an elevated temperature. Prolonged recourse to an excessive dietary in the presence of continued fever is less likely to be followed by a successful issue than is a discriminating effort toward a proper minimizing of food-consumption. Among patients of this class the ultimate gain of body weight, if secured, is determined not so much by a persistence of the heroic feeding, as by *subsidence of the fever*. In a very large number of cases this symptom represents the single decisive feature of the entire struggle against the disease. With the disappearance of fever, nutrition may rapidly improve, even despite the ingestion of a *diminished* quantity of food, although, as a rule, appetite and digestion are enhanced so materially that but little difficulty is experienced in administering a generous allowance.

While clinical observations point to the inadvisability and futility of ruthlessly engorging the consumptive during the existence of high fever, it is, nevertheless, true that larger quantities of food should be given the pulmonary invalid than to sufferers from other diseases exhibiting the same degree of temperature elevation. Obviously, the administration of solid food in generous amount would be imperatively contraindicated in typhoid fever or pneumonia attended by a temperature of 102° F., but it does not follow that the nourishment of the consumptive should be similarly restricted at all hours of the day. Save in the presence of acute tuberculosis or inflammatory processes, the malady is essentially chronic and wasting in character, as opposed to diseases of self-limited duration. Moreover, the elevation of temperature is rarely continuous during the entire twenty-four hours, the morning remissions in the majority of non-acute cases permitting the ingestion of considerable quantities of solid food once or twice daily.

While it is desirable that no heavy meal be eaten at a time of temperature elevation, it is frequently possible to administer a hearty breakfast and a moderately generous midday meal to patients exhibiting an afternoon fever of 101° to 103° F. The character of the food given at such times need not differ materially from that already described for pulmonary invalids in general, the essential consideration being the selection of highly nutritious and easily digestible articles, prepared in most appetizing form. During the latter part of the day, after the rise of temperature, the food should consist principally of liquids, milk being freely supplied, together with raw eggs, beef-juice, broths or soups, and specially prepared foods, as somatose or tropon. Under these circumstances it is an excellent plan to give the food in small quantities at frequent intervals, but *with the utmost punctuality*. This method of procedure may be continued until the patient falls asleep for the night. Upon awakening at subsequent intervals it is desirable to utilize the opportunity afforded for reinforcing the nourish-

ment, by giving once or twice during the night a glass of milk, a raw egg, or a portion of beef-juice.

In acute cases with rapidly extending infection, accompanied by constant high fever and other severe constitutional disturbance, the indications point conclusively to the expediency of a simple diet consisting of milk or other liquids. The administration of two or three quarts of milk daily with six to ten ounces of beef-juice and three drams of somatose represent, if properly digested and assimilated, sufficient caloric energy to retard tissue waste for a temporary period, with a minimum burden to the digestive organism.

Independent of fever, disorders of digestion, with or without associated kidney disturbance, may assume such proportions as to demand important modifications of diet. It is not surprising that the functional power of the organs concerned in digestion, assimilation, and elimination should show clinical evidence of impairment, in view of the toxemia, the malnutrition, the general exhaustion, the lack of exercise, the non-adaptability of the food, and the development of psychoneuroses. The various symptoms of digestive derangement may be exhibited in the *entire absence* of pathologic lesions of the stomach or intestine, as well as in connection with *definite structural change*. It is also quite remarkable that severe dyspeptic disturbance may take place in the midst of normal gastric secretions, as shown by repeated analyses.

The organic changes responsible for the development of symptoms referable to the digestive apparatus may consist of acute or chronic catarrhal conditions, dilatation or prolapse of stomach, passive congestion, and finally of actual tubercle deposit. In addition to a diminished motor power of the stomach the disturbance of function, as determined by gastric analysis, may partake either of a hypochlorhydria or hyperchlorhydria. As a general rule, *incipient* cases present but slight deviation from average individuals as regards the character and sufficiency of stomach secretions. In *advanced* cases, while hydrochloric acid is occasionally found in excess of the normal, the reverse is far more frequently true. Dyspeptic cases exhibiting symptoms of profound functional impairment, without demonstrable abnormality of stomach secretions, are usually victims of a greater or less degree of general nervous disturbance. Among patients who are anemic, ill nourished, and psychoneurotic, it is inevitable that digestive complaints must take their place in the train of nervous disorders.

A considerable proportion of the digestive derangements observed among consumptives without fever or obvious structural change in the abdominal viscera are of undoubted *nervous* origin. As a general rule, the complaints made by tuberculous sufferers from indigestion bear no relation to the extent or character of the pulmonary involvement, which in many instances is comparatively insignificant. The consideration of prime importance, therefore, in such cases is the persevering effort toward an amelioration of the functional disturbance.

Among the symptoms more frequently presented are obstinate loss of appetite, occasional pyrosis, distress in stomach or bowels shortly after eating, and constipation. The impairment of appetite suggests a definite repugnance for food of any description. The anorexia is often confirmed, not only by the protests of patients as to their inability to swallow food, but also by the prompt occurrence of nausea and vomiting. This is not infrequently of sudden onset, taking

place in the very midst of a forced meal. It is not uncommon for afebrile pulmonary invalids in advanced stages to eat a portion of the food without discomfort, and often with apparent relish, only to suffer a distressing interruption by the onset of vomiting unannounced by nausea. This sudden and untimely manifestation, unpreceded by precautionary warning, is of unquestionable reflex origin, being induced in many cases by cough, and in others by eructations of gas from the stomach. In either event reflex irritability is a factor of pronounced import. The sensation of nausea, if recognized during the taking of food, demands, at least for the time being, an immediate suspension of nourishment. After resting quietly in the recumbent position for ten or fifteen minutes, the invalid is often enabled to resume the meal, and persist to a successful conclusion without recurrence of nausea.

Many patients complain of a disagreeable feeling of abdominal distention after eating, without actual nausea. This may occasionally amount to a definite sensation of pain, usually appreciated in the lower part of the abdomen. Complaint may be made of either constipation or diarrhea, frequent headaches, general lassitude, disturbed sleep, and bad taste in the mouth, the tongue often being furred and the breath offensive. Under circumstances such as these modifications of diet for pulmonary invalids become an imperative necessity.

In view of the nervous element, which so frequently predominates, it should be borne in mind that the regulation of food for such patients constitutes but a part of the general scheme of rational therapeusis. Recourse should be taken to the power of suggestion, rest strictly enjoined, and special attention devoted to the details of environment. As the general tone of the system is promoted through the influence of physical, nervous, and mental repose, a proportionate improvement of appetite and digestion will take place. The efficacy of these factors is equal, if not superior, to the benefits derived from restriction of diet. It is incumbent, however, upon the physician to so adjust the nourishment as to enhance the appetite, if possible, and conciliate the digestion without too great sacrifice of weight and strength. To this end digestive disturbances should be treated not so much by diminishing greatly the total quantity of food, but rather by its judicious selection and time of administration.

An exclusive liquid diet is often advantageous during the first few days, but should be reinforced by easily digestible solid food as soon as practicable. Milk constitutes an important article of diet for pulmonary invalids, and is borne exceedingly well by the majority of patients. While admittedly productive of digestive derangements in a few exceptional cases, the vast majority of patients evincing a disinclination to milk, are enabled, by means of firm but gentle persuasion, to overcome their natural repugnance. In intractable cases it may be peptonized or diluted with seltzer or other sparkling water. Prolonged adherence to the so-called "milk cure" is of extremely doubtful utility. To supply the deficit in carbohydrates and proteids, it is desirable to add cautiously to the dietary raw eggs, beef-juice, somatose, soups, broths, oysters, squab, chicken, fish, light puddings, and custards, with an ultimate trial of lean meats and succulent vegetables. Sweets, starches, and fats, together with fruit and pastry, should be denied to patients with diarrheal disturbances, or with other evidence of gastro-intestinal indigestion. Also these should be interdicted, together with alcohol in any form, for

those with pronounced uric-acid diathesis, the nitrogenous foods usually being productive of less harmful results than the carbohydrates. The use of medicinal measures for the control or alleviation of digestive disturbances will be discussed in connection with the treatment of special symptoms.

True progress in the art of medicine is not dependent *alone* upon the results of laboratory investigation, nor the acceptance of theories thus deduced, no matter how alluring or convincing. To the established facts of clinical experience there should be accorded an equal right for recognition in the endeavor to judge sanely regarding the proper diet for consumptives amid the present diversified state of opinion. From the light afforded by careful observation, it is clear that the adoption of a standard diet applicable to pulmonary invalids in general is eminently impracticable and unscientific.

CHAPTER XCIV

THE SCOPE OF THE SANATORIUM AS A THERAPEUTIC FACTOR

THROUGHOUT the preceding pages devoted to general considerations of treatment, an effort has been made to emphasize the great importance of attention to detail, rest, outdoor living, and superalimentation as the fundamental principles of management. It is self-evident that the complete application of these cardinal features is utterly impossible without the maintenance of strict disciplinary control. In fact, the essential prerequisite for the successful development of any elaborated system of management is found in the rigid enforcement of a suitable régime, for which unusual facilities are afforded in *special institutions* for consumptives.

Inspired by the excellent results attained through the influence of continuous autocratic supervision, phthisiotherapeutists have been instrumental in establishing numerous sanatoria in various parts of the world. Regardless of climate, location, or immediate environment, the primary function of these institutions was thought by some to relate principally to the means thus secured for insistence upon disciplinary control. This was made much easier in sanatoria, partly as a result of important details of construction. In properly located, thoroughly equipped, and well-conducted institutions, rest in the open air, at all hours of the day and in nearly all states of weather, is permitted upon specially constructed verandas, solaria, and sleeping porches.

In view of the opportunities thus afforded for the inauguration of a suitable method of living, the idea has become somewhat prevalent that a perfected system of regimen obtains *only* within closed sanatoria. It is not true, however, that the methods in vogue in such closed resorts for consumptives are essentially different from those frequently employed among a similar class of invalids outside of institution walls. The term "sanatorium régime" should be understood to apply merely to the maintenance of a proper method of living within an institution

designed for this special purpose, rather than to define a radically distinctive *method* of management. Although it is much easier to exact implicit obedience within sanatoria so constructed and equipped as to furnish exceptional opportunities for systematic management, yet by dint of earnest effort on the part of a resourceful medical attendant, an equally rational supervision can be successfully instituted elsewhere.

No reflection is intended upon the great practical utility of closed sanatoria, but issue is taken with the assumption of their invariable necessity in order to secure the fulfilment of a satisfactory régime. It is also insisted that the ample recognition accorded to such institutions, with reference to their large field of usefulness, does not justify a belief in the practical appropriateness of sanatorium life for all cases of consumption. Unfortunately, the doctrine of sanatorium control, which has been advocated so zealously during the past decade, has been literally accepted by many as the exclusive means of securing satisfactory results.

In order to minimize the evils resulting from extravagant and erroneous ideas entertained concerning the rôle of the closed institution for consumptives, it is important that the supporters of the sanatorium movement should assume an eminently conservative position. It seems fitting to institute an inquiry as to the precise scope of the sanatorium treatment of consumption, without bias, prejudice, or preconceived ideas, save those founded upon the substantial facts of experience. It is not desired in the merest way to detract from the honor and glory of the early pioneers who devoted their lives to a cause so worthy, and who are destined to leave a lasting monument to their ability and personal sacrifice. The movement for the treatment of tuberculosis in closed institutions originated with Bodington, of Warwickshire, England, in 1839. The theories advanced were subjected to extreme ridicule, and the promoter doomed to much personal disappointment and humiliation. His ideas were subsequently championed by Herman Brehmer, of Germany, who, despite much bitter opposition and contumely, succeeded in establishing a sanatorium for consumptives at Goerbersdorf, in the Silician mountains. Following the demonstrated soundness of Brehmer's views, and stimulated by his example, several prominent physicians were encouraged to adopt similar methods. Notable among the early followers were Dettweiler and Walther, Sir Herman Weber, and Trudeau. In recent years the sanatorium idea has taken deeper root than ever in the professional and public minds, until the outgrowth has assumed such proportions as to endanger its practical efficiency and benevolence.

Though inspired by no spirit of iconoclastic criticism, it is believed that the time is opportune for a presentation of some negative phases of the sanatorium proposition. With no derogation of the noble work performed by the advocates of this method, the plea is presented that, following their example in its essentials, and profiting by their experience, equally good results may be accomplished without the aid of special institutions. In this connection an appreciative acknowledgment should be made of the peculiarly beneficent mission of the sanatorium from the standpoint of public prophylaxis.

Attention has already been called to its humanitarian scope and economic value, as well as to the pronounced educational influence, which reflects one of its chief advantages. In appreciation of the great usefulness of sanatorium management for certain carefully selected

cases, it is designed to discuss merely its medical scope for *non-indigent, non-hopeless* consumptives, regardless of climatic location. Paradoxic as it may appear, the propositions are advanced that residence within a closed sanatorium offers to a class of cases the best possible conditions to be obtained, and that summary recourse to complete institutional régime is distinctly prejudicial to the best interests of others. These differences pertain to such determining individual factors as the financial status, temperamental peculiarities, and domestic conditions. Other considerations which may justly obtain in certain instances are the possible accommodations to be secured *other* than institutional, and the character of medical counsel to be obtained either within or without the sanatorium.

The sole claim of sanatorium advocates relates to the degree of success possible of attainment in establishing and maintaining a perfected system of disciplinary régime. An unceasing medical supervision is sometimes necessary for the well-being of certain cases, while an equal amount of surveillance is distinctly detrimental to the best interests of others. A particular regard for the minutest detail, either within or without an institution, is dependent almost entirely upon the solicitous attention of the physician. It is almost purely a question of personal equation, and demands, in addition to a masterful familiarity with tuberculosis, a certain aptitude for the peculiar requirements of the position, a devotion to the work for its own sake, an interested regard for the slightest welfare of the patient, broad sympathy, infinite tact, intuitive perception, and unyielding firmness. These qualities may be utilized for the benefit of the consumptive without a closed institution, which in most instances is a valuable adjuvant rather than a *sine qua non*. It is the man, not the institution, influencing the degree of coöperation and hearty good-fellowship between physician and clientele, which alone can insure a proper disciplinary control. By as much as it is not the sanatorium alone, but also the attending physician determining the influence for good, by the same token must it be remembered that it is not the disease to be considered solely, but the invalid as well. This presupposes the consideration of other factors than purely medical or sociologic features. For the consumptive the question of success or failure frequently depends upon the ability to adapt oneself to unusual conditions, and in this quality the invalid is often found deficient. The wisdom of an intelligent modification or adjustment of the immediate environment to satisfy peculiar individual requirements is readily apparent. There surely is not implied an invariable necessity of confinement within sanatorium walls, although this is admittedly desirable for many cases otherwise difficult of management. In addition to intractable cases, patients for whom sanatoria are particularly appropriate are those with such limited finances as to preclude the acquirement of satisfying conditions without the benevolent aid of partially endowed sanatoria. The founding of modest institutions of this character, providing excellent accommodations to worthy consumptives at a *minimum of expense*, without ostentatious display or sole regard for beauty of architectural design, represents the most substantial form of true charity and practical philanthropy.

It has been asserted that the special advantages sometimes accruing from a properly conducted sanatorium are not altogether inherent to the institution itself. The erection of imposing structures and the laying

out of beautiful grounds sometimes represent in themselves only the taste and ambitions of the founders, rather than the practical needs of the inmates. Ample porch accommodations, with wise provision for private balconies, rooms with sunny exposure, proper facilities for heating and ventilation, and finally a generous tempting cuisine, of vast importance though they be, are none the less to be secured in many instances outside of closed sanatoria. The attainment of suitable surroundings and conditions is frequently most difficult, and imposes a serious tax upon the time, energy, and perseverance of the medical attendant; yet in most communities this may be accomplished through the personal attention of physicians willing to recognize their obligations with reference to such details.

Experience has taught that the medical adviser, if he so elects, may devote sufficient supervisory attention to his patient outside an institution, and through the exercise of painstaking effort may inaugurate proper methods of living somewhat along the same lines as in well-regulated sanatoria. The same well-recognized principles may be enforced upon a smaller scale, and frequently more to the actual advantage of the pulmonary invalid. If detailed autocratic supervision, which in many cases is admittedly indispensable for the accomplishment of the best results, was the *only* essential factor involved in a question relating to the lives of unfortunates, the decision would be invariably made in favor of the closed sanatorium upon some remote hilltop. The fact remains, however, that to the consumptive there should be accorded a consistent regard for certain other fundamental considerations. In spite of his bodily infirmities he remains a human being, possessing essential peculiarities of temperament and disposition of no small significance. The factors inherent to the individual are sometimes of more transcendent importance than the tuberculous infection. A problem of this character cannot always be adjusted properly by a summary recourse to its medical and sociologic aspects. While life in a closed sanatorium is perhaps more strictly in accordance with the principles of modern phthisiotherapeutic thought, nevertheless, in its every-day application to special cases, its non-adaptability is not infrequently apparent.

It may be questioned if the uniformly good results which have been reported, demonstrating the value of sanatorium treatment, are dependent entirely upon the institution. It is fair to assume that a consideration of vast importance relates to the incipient character of the cases admitted for treatment. Rejection of invalids with advanced infection is in accordance with the avowed purpose of nearly all sanatorium authorities, who have reported statistical observations. It is, of course, natural that, as a rule, sanatoria should extend a welcome only to such cases as offer an eminently favorable prognosis. At some popular institutions it is stated that patients are admitted from the list of those who have passed the necessary examination, not in the order in which they have applied, but according to their physical condition, the most favorable cases being admitted first. A review of the annual medical reports emanating from several of the sanatoria in this country has recently shown that the condition is described as favorable in an exceedingly large proportion of the patients. Digestion was unimpaired in the majority of cases upon admission, the average maximum temperature being over 100° F. in a very few instances. Many are reported to be

without tubercle bacilli upon arrival. Nearly all cases were practically devoid of important complications. In some of the cases admitted to sanatoria the condition is of so doubtful a character that the patients are kept under observation in order to arrive at a definite diagnosis, yet institutions both at home and abroad are accepting but a *small proportion* of the consumptives applying for admission.

It is difficult to understand how individuals with incipient infection, without temperature elevation, digestive impairment, or other complications, and frequently without bacilli, can require upon the merits of their condition that degree of medical attention necessitating residence within a closed sanatorium. As regards those institutions, harboring a miscellaneous aggregation of consumptives, it would appear that the social conditions could not be such as to promote the happiness and contentment of invalids.

Aside from these considerations, which surely are more substantial than sentimental, may be mentioned the value of the psychic element to

Fig. 141.—Summer residence used annually for a group of selected patients.

be observed from occasional judicious *change of residence* and *immediate surroundings*. This potent influence for good is not obtainable under the fullest interpretation of the so-called institutional régime. As the result of some clinical study in an effort to recognize essential facts, to apply established principles, and to effect a mutual interadaptation of individuals to special conditions, certain conclusions have gradually assumed shape. The conviction has thus been forced that for many cases the idea of a home and genuine home life is the ideal spirit to be fostered, together with a judicious amount of medical control. If close daily supervision of early cases is not invariably demanded, the medical adviser may exercise sufficient personal direction over his patients, if he so elects, in private abodes, promoting in many cases the happiness and social welfare of the invalids. The careful selection of a residence meeting all known requirements as regards location, sunshine, porch room, and outdoor sleeping accommodations, the wisest grouping of a chosen few with

reference to congeniality, temperamental peculiarities, tastes, stage of the disease, and financial ability, the presence of a competent housekeeper and nurse, and finally the directing influence of a non-resident medical attendant, must afford a combination sufficient to produce satisfying results. In Fig. 141 is shown a summer residence peculiarly adapted to the needs of a few patients. The house, octagonal in shape, is entirely surrounded by a screened porch, which is divided into sections by intervening wire screening and adjustable awnings.

The medical control should not be permitted to predominate offensively, but should continue as a non-intrusive factor in the constant physical guidance of the temporary household. It seems unnecessary to more than mention the improved psychic effect of such an environment, which exercises a potent influence upon many pulmonary invalids. In

Fig. 142.—Same residence as preceding. Section of porch communicating with sleeping-room.

this manner much of the ennui and nostalgia, with resulting general depression, so frequently observed in institutions, may be effectually obviated. On the other hand, to those previously unaccustomed to separation from home, sanatorium sojourn is often utterly beyond their powers of individual adaptation. In pursuance of the foregoing ideas it has been my custom for many years to provide suitable accommodations for my patients in residences appropriate for varying classes. These abodes are selected either on the outskirts of Denver or in the mountains of Colorado, according to the season. This grouping of patients, particularly during the warmer weather, in the midst of new surroundings, has been found, as a rule, especially advantageous. As a result of the constant attendance of an efficient nurse, a suitable régime is maintained somewhat along the lines of a cottage sanatorium. Some

idea as to the private accommodations for patients of this class may be afforded by reference to the accompanying photographs.

The preceding course of remark is intended to apply to invalids seeking climatic advantages away from home, but does not refer to exceptionally intractable cases. Among patients of the latter class, autocratic control is urgently indicated, the routine discipline of well-regulated sanatoria being found subservient to implicit obedience and hence conducive to best results. The necessity of careful individualization is thus apparent, the most suitable environment for one being quite inappropriate for another.

Apropos of the foregoing considerations, it is of interest to compare the advantages of the sanatorium with certain objectionable features

Fig. 143.—Another view, same cottage.

relating to the care of pulmonary invalids in health resorts when accompanied by members of the immediate family. Under such circumstances, obvious difficulty is experienced in many instances in securing an atmosphere of complete repose. In addition, the continuous presence of relatives is frequently found inimical to perfect discipline. Disturbing factors arise by virtue of the conflicting opinions sometimes entertained by a parent, husband, or wife regarding the appropriateness of the régime, and by the lack of insistence upon conformity to prescribed instructions. The physician is likely to be seriously handicapped by the stubbornness and perversity of accompanying relatives, whose temperamental peculiarities and disposition may demand the display of more tact, discretion, and firmness than the control of the patient. Unwarranted petting, condolence, or indulgence is responsible in many instances for serious retardation of recovery. Provided relatives evince a cheerful acceptance of the instructions detailed by the physician, it frequently follows

Fig. 144.—Mountain residence providing excellent accommodations for six or eight patients.

Fig. 145.—Section of porch of same house as preceding.

that, despite their cordial acquiescence, the patient is wont to refuse to near ones that implicit obedience which could otherwise be obtained. The influence of home life, even through no negligence or perversity of judgment on the part of the family, is sometimes responsible for unfortunate laxity of discipline. In addition to the occasional likelihood of physical or social indulgence, the hours of rest in the open air are less apt to remain undisturbed, and the ingestion of food, upon the whole, less satisfactory. It is unnecessary to state that these objections do not invariably obtain, the efforts of the physician in some cases being vigorously reinforced by accompanying relatives. In undertaking the management of pulmonary invalids, particularly serious cases, in private houses, it is desirable to secure the services of a forceful, quiet, and discreet nurse, through whose tact and firmness there may be secured implicit compliance with directions. Given an atmosphere of

Fig. 146.—Mountain residence with sleeping porches upon eastern and southern exposures.

repose and contentment in a well-chosen house, satisfactorily provided with porch accommodations and an abundance of appetizing food prepared in accordance with individual tastes, the physician is in a position to elaborate a full conception of institutional régime.

An important and somewhat neglected aspect of the closed sanatorium is the possible rôle of such institutions as centers of scientific research, but this feature, which is recognized as of immense value, may be amplified to the fullest extent only in those institutions supported by State aid. Ample opportunity for original laboratory investigation should obtain in sanatoria conducted for the benefit of indigent consumptives. Upon the other hand, clinical observation of a high order of merit is permitted outside of institutions to physicians possessing the proper equipment and ideals.

An economic phase of the sanatorium movement is worthy of passing mention. It appears, from a practical standpoint, that more bene-

Fig. 147.—Mountain residence providing outdoor sleeping accommodations for ten patients.

Fig. 148.—Another view of same house. Taking the cure in the mountains.

ficent results may be attained by the construction of a greater number of tuberculosis dispensaries, and by the more generous maintenance of anti-

tuberculosis societies than by the expenditure of extravagant sums of money for the erection of magnificent public or private sanatoria. The absurdity of erecting an imposing structure for the ostensible purpose

Fig. 149.—Five-room cottage in mountains with sleeping porch.

of *housing* patients with *most incipient* infection without constitutional impairment who are enjoined to *remain constantly out-of-doors* is quite apparent. The cost of such institutions is assuredly out of all proportion

Fig. 150.—Another five-room cottage in the mountains with sleeping porch.

to the benevolent results. On the other hand, at a less expense, enduring benefits can be obtained through the establishment of modest dispensaries. Protest, therefore, should be made against the unreasonable

expenditure of public money for costly buildings, which, in many instances, are injudiciously located in damp, moist regions or in immediate proximity to large centers of population. It frequently happens that in proportion as the cost for construction is excessive, the funds for

Fig. 151.—Six-room cottage in mountains, with outdoor sleeping accommodations upon three sides.

maintenance are insufficient. This is particularly true of several prominent sanatoria in England and America. It should be emphasized that no practical advantages to the consumptive accrue from elaborate details of construction or superfluous equipment.

Fig. 152.—Small cottage with sleeping porch.

Despite ample facilities for the accommodation of tuberculous patients in England, the King's sanatorium near Midhurst has been recently completed at an approximate expense of $1,000,000. The

Fig. 153.—Small cottages with sleeping porches.

Fig. 154.—"Rock Rest."

outlay in many respects was not strictly demanded, yet no provision was made for the admission of cases which were not entirely charitable. The cost of the Beelitz Sanatorium near Berlin is even more prodigious.

Three million dollars have been expended for its construction, with provision, however, for 600 beds. It is hardly necessary to present photographs of the various sanatoria in this country and abroad in order to illustrate the beauty of architectural design and the general magnificence of construction. The majority of readers are already quite familiar with the general features of American sanatoria, the most modern of which possess administration offices in close proximity to the buildings devoted to the housing of patients. Private sleeping balconies communicating directly with an inside chamber are provided almost invariably, while protection is afforded in extremes of weather from the summer heat and the winter storms. It is important that all rooms occupied by consumptives should be spacious, sunny, and well ventilated. These con-

Fig. 155.—Small inexpensive cottages.

siderations are particularly important with respect to a common dining-room, in which the air during the winter season is likely to become noticeably foul. Porches should be constructed in nearly all available places, especially in protected corners, in order that shelter may be secured when necessary from sun, wind, snow, and rain.

Waiving any mention of climatic considerations, it is important that due attention be given to the matter of location. If the teaching for years as to the efficacy of fresh air is correct, it is essential that institutions designed for the exclusive aid of consumptives should be so situated as to render the greatest possible benefit. It is important that sanatoria should be located apart from densely populated districts, and preferably in mountainous regions, rather than upon the lowlands. The site for the institution should not be selected upon the extreme crest

of an elevated region, on account of the unnecessary exposure to severe winds. For the same reason its location upon the unprotected plains, particularly in the higher altitudes, is peculiarly inappropriate, no natural shelter being afforded from the heat of the sun during the summer months, and from the boisterous wind occasionally prevailing at other seasons. Certain disadvantages also accrue from placing the buildings in deep valleys, on account of the lesser hours of sunshine and the greater tendency to dampness, with inferior drainage. An ideal site for a sanatorium, or, in fact, for all buildings especially designed for pulmonary invalids, should be upon the southern slope of a hill or near the base of a moderately high mountain. In order to afford shelter from the prevailing winds the buildings should be located, according to regional weather

Fig. 156.—Six-room cottage, somewhat primitive, but quite comfortable and with ample porch room.

conditions, either to the east or west of a spur extending southward. It is still more advantageous if the mountain rises to a considerable distance in the far background, even to a height of several hundred feet, as shown in the accompanying illustration of a private residence (Fig. 157). The soil should be dry, porous, and sandy, although a rocky formation is not undesirable. On account of the necessity of irrigation in dry climates, no elaborate attempt should be made to beautify the grounds by laying out expansive lawns, or by disposing flower-gardens in the immediate vicinity of the sanatorium, although such ornamentation greatly adds to the outward attractiveness of the institution. Undoubted benefit accrues to the pulmonary invalid from a pleasing landscape. Attractive views, combining land and sky effect, contribute to a remarkable degree in breaking an unceasing monotony. Definite

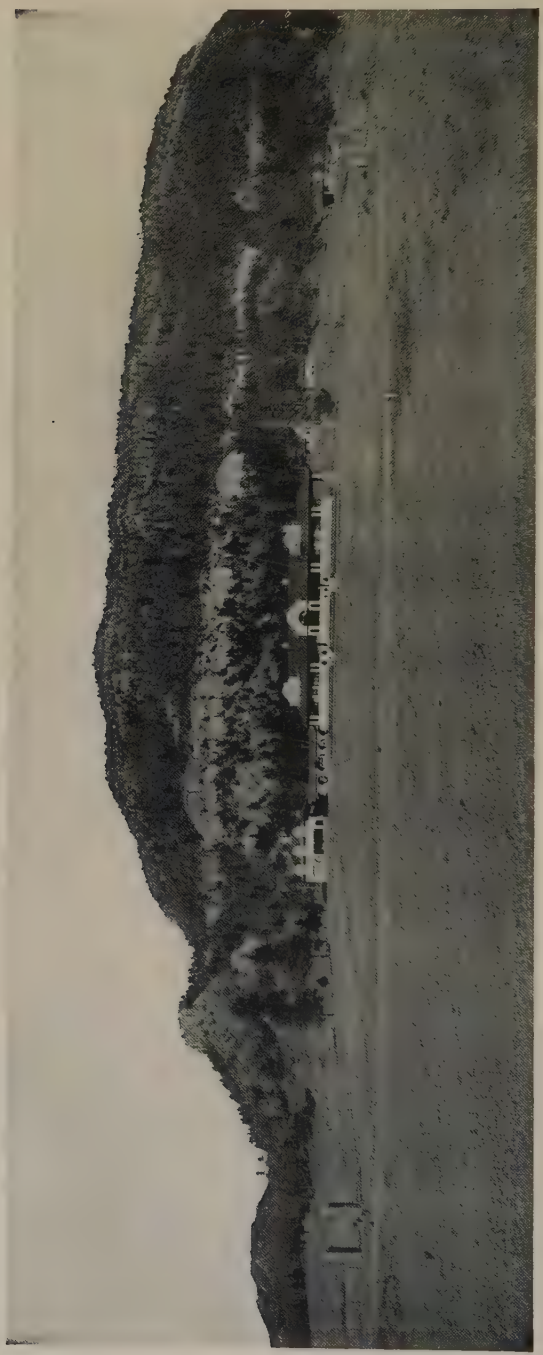


Fig. 157.—Private residence, with southern exposure, at an altitude of 7500 feet. The main building is rectangular in shape, surrounded upon three sides by a wide porch. Note mountain in background.

Fig. 158.—View of mountain-range from porches of summer cottages.

inspiration and elevation of spirits are not infrequently afforded by the sublimity of scenic grandeur witnessed in mountain resorts. In Fig. 158 is shown the delightful view afforded from the porches of cottages for consumptives at Estes Park, Colorado.

CHAPTER XCV

THE RÔLE OF CLIMATE IN THE TREATMENT OF PULMONARY TUBERCULOSIS

In discussing the importance of an open-air existence in a previous chapter, brief allusion was made to the vagaries of opinion entertained regarding the value of fresh air, to the apparent exclusion of all other atmospheric influences. Early in the general consideration of treatment, attention was called to the acceptance of unsound principles from time to time by the medical profession. No more unfortunate delusion has appeared than belief in the equal suitability of all climates for the management of tuberculosis. Although the substantial value of certain combined atmospheric attributes characteristic of localities has been recognized from the earliest days of medicine, and continuously attested by the irresistible logic of clinical experience, a somewhat bitter iconoclasm has been exhibited in late years concerning the beneficial influence of climate. There has even arisen a tendency to renounce completely its value as a therapeutic factor, the opponents offering the contention that an open-air existence, regardless of essential meteorologic conditions, represents the sole important desideratum.

An inquiry instituted for the purpose of determining what foundation,

if any, exists for the inculcation of such belief, discloses an utter disregard for scientific principles or established clinical facts. The position of climate as a factor of exceeding value in the treatment of consumption can never be assailed by the mere expression of opinion. No dictum is worthy of general acceptance if inspired by other than a disinterested desire for truth. The only rational basis either for faith or for disbelief in the efficacy of climate must exist in the fundamental logic of clinical facts supported by broad practical deductions founded upon a study of atmospheric phenomena and meteorologic laws. A renunciation of climatic truths is justified only by the submission of demonstrable data sufficient to constitute irrefutable negative evidence. In view of the accumulating testimony concerning the physiologic effect of climate, and the mass of clinical evidence already adduced in substantiation of such an influence, it almost appears that the burden of proof rests with any who may have indulged in more or less violent repudiation.

There are but *two arguments* worthy of consideration, to be advanced by the *opponents* of climate: first, the knowledge that some cases of tuberculosis ultimately recover in any *locality*, as the result of a proper outdoor régime; secondly, that some fail to secure good results although subjected to a pronounced change of climatic conditions.

The *first proposition* relates to the occasional arrest of a disease formerly supposed to be almost entirely hopeless. Considerable optimism is naturally to be expected from the recognition of such beneficent possibilities for early cases, through the *influence of a properly conducted method of living*. Consumption, however, irrespective of climate, may become arrested in some instances, *despite unhygienic surroundings, undue exposure, insufficient food or clothing, and financial distress*, an important factor in the evolution of complete arrest being the measure of *inherent individual resistance*. The sequence of thought is plain to the effect that, even in unfavorable locations, a certain proportion of early cases must inevitably get well upon simple change of environment and mode of living. This does not necessarily imply that such change alone is all-sufficient for general application, but indicates merely that in some incipient cases important modifications of previous conditions and surroundings may turn the balance temporarily in favor of recovery. In many instances the predominant factor consists of the personal supervision of hygienic details, the importance of which is not open to dispute. The overwhelming evidence that consumption is sometimes arrested in unsuitable regions is far from predicating the assumption that climate is of no value for the enormous remaining number of pulmonary invalids. As well might it be inferred that because some patients recover from various diseases without medication, judicious recourse to drugs is in all instances of *no* avail. Carefully directed mental suggestion has been found of therapeutic efficacy among a class of nervous invalids, but the recognition of this scientific principle affords no justification for the development of a system of religious belief suitable for the cure of bodily ills. In other words, the recognition of the possible benefit accruing to individuals having *complaints* does not warrant the assumption that this cult is applicable to *disease*. The analogy suggested between apparent supernatural healing and the utter repudiation of climatic influence for consumptives is more real than imaginary, the principle invoked in either instance being the acceptance of a demonstrable truth, but an utter misinterpretation of its signifi-

cance and applicability. The fact that invalids occasionally recover from incipient tuberculosis without climatic change, is no more to be considered as an argument against the wisdom of its intelligent application in individual cases, than is the recovery without operation of a given patient with appendicitis to be considered a reflection upon the general expediency of surgical interference.

The *second consideration* leading to pronunciamentos regarding the non-efficacy of climate, relates to the not *infrequent failure* to secure arrest in favorable regions. That grievously unfortunate conditions bestrew the path of many victims of tuberculosis in health resorts no physician of experience in such localities can deny. It is important to inquire as to the underlying causes of the distress observed in climates popularly believed to possess some direct influence upon pulmonary invalids. The fact is at once developed that there are sent annually to health resorts a considerable number of phthisical patients, who should have been permitted to end their days at home. It is also apparent to the experienced observer, that but little judgment is displayed in many instances in the *selection* of *a locality* appropriate for the individual needs of those who, upon the merits of their condition, require climatic change. As will be shown presently, the utmost discrimination and acumen must be exhibited in each case in determining the cardinal principles upon which the choice of climate should be based.

There is no single climate applicable to all cases of consumption. The peculiarities of temperament, the ever-varying combinations of physical signs, the associated disturbance of circulation, digestion, and elimination, and the financial status furnish a combination that must be adjudged *in relation to the known physiologic effect of the various climates and the therapeutic action to be desired.* In many cases failure to attain the best results from climatic change is undoubtedly occasioned by lack of familiarity with the predominating atmospheric attributes in different localities, and their physiologic effect upon an organism modified by disease and by previous environment.

Although the unsuitability of a particular climate is often a potent cause for ultimate disaster, this feature *per se* does not fully explain the deplorable results forced upon the observation of physicians in health resorts. It should be borne in mind that, in a vast majority of instances, failure takes place not because of climatic change, but *in spite of it*, the essential factor in determining the final issue being the complete non-conformity to hygienic principles of living. An astonishingly large number of patients are led to avail themselves of the supposed advantages of an injudiciously selected climate, without the *slightest appreciation of the nature and extent of their personal responsibilities.* Some are entirely uninstructed or, at best, are without that degree of medical supervision which insures compliance with directions. Others, as the result of irrational advice, are impelled to indulge in various excesses sufficient to destroy even a remote possibility of recovery. A very considerable number of ignorant, frivolous, and impatient consumptives float like veritable flotsam and jetsam *upon their own initiative*, drifting aimlessly from one resort to another. Such patients are, as a rule, but slightly amenable to judicious governing influences, and come under medical observation only at times of acute manifestations.

In former years climatic change was often advised regardless of the

constitutional condition of the patient, or of the extent and activity of the disease. Localities possessing radically different climatic conditions were indiscriminately recommended to phthisical patients. Invalids chancing to consult a number of physicians before directing their steps toward a distant clime, might have been ordered, according to the choice of their advisers, to such widely differing regions as Colorado and the Bermudas, Florida and the Adirondacks, New Mexico and portions of North and South Carolina, California and Arizona. It is obvious that, if the climatic conditions peculiar to one of these localities are adapted to special individual needs, some of the other regions must be less favorable in their influence, if not distinctly prejudicial.

The errors of judgment, which have been displayed in the selection of climate, have served only to acccentuate the unfortunate results of deferred diagnosis. Temporizing delay on the part of the physician after the nature of the condition has become established is explanatory, in large measure, of the indifferent success attained after removal to favorable climates. It is also responsible to a considerable extent for the reflections unjustly cast upon the utility of climatic change.

Ill-considered advice with reference to the policy of therapeutic management many times has been imparted by medical attendants, at home and in health resorts. Until recent years it has been no uncommon experience in favorable climates to observe patients who have been admonished to avoid doctors, to climb mountains, to ride horseback, and to drink whisky. Some physicians, in sending their patients away from home, have seen fit to issue instructions as to the entire future conduct of the patient. Many invalids have been told to beware of medical advice, or at most to secure an opinion as to results obtained only upon the lapse of several months after arrival. Many of these, as a direct result of the injudicious counsel of their home advisers with reference to exercise, work, or manner of living, are compelled to seek medical aid much sooner than anticipated. The reputation of climate has also been made to suffer for numerous errors of professional judgment committed by resident physicians. It is idle to comment upon the itinerant, non-ethical *talent* sometimes assuming to exercise jurisdiction over the physical destinies of the consumptive in health resorts. It is apparent that medical counsel received from these sources has too often been delivered without the incumbrance of knowledge or the handicap of conscience.

In but comparatively recent years, has the necessity of rational living been insisted upon by medical observers. In any discussion bearing upon the relative merits of climatotherapy and the so-called home treatment, due cognizance should be taken of the fact, that the doctrine of hygienic living was early emphasized by medical workers in favorable climates. Largely through their efforts the profession has been taught the importance of rational living, and advised concerning the rôle of climate as a valuable adjuvant to other measures of therapeutic management. During the past decade an unceasing endeavor has been made by observers in healthful localities, to inculcate among general practitioners a degree of familiarity with the practical side of climatotherapy. Numerous appeals have been made for the exercise of a wise discrimination concerning the character of invalids permitted to journey to a distant land.

The non-recognition, in former years, of the importance attaching to hygienic details, is being replaced by a tendency to exalt the value of a suitable régime far above the influence of climate. An unfortunate phase of American life is the tendency to go to extremes. Once awakened to the importance of strict hygienic methods, the medical profession has been prone to accept this feature as the chief therapeutic indication. No greater menace to the welfare of the consumptive now exists than the further development of the delusion regarding the futility of climatic change. It is not surprising, however, in view of the incontestable merits of properly regulated methods of living in any locality, and the many causes for failure in health resorts, that an inclination is displayed to regard fresh air, without reference to modifying conditions, as the sole atmospheric desideratum. The fallacy of such reasoning is apparent upon consideration of the affirmative aspects of climatic influence.

Affirmative Evidence.—The evidence upon which there may be returned a final verdict as to the beneficent rôle of climate is found: (1) In the known physiologic effect produced by various climatic attributes, either separately or jointly; (2) in the unimpeachable testimony presented as a result of impartial clinical observation.

Preliminary to any review of the demonstrable influence of atmospheric conditions upon the human organism, it is well to define what is meant by climate, and to enumerate its essential factors. Reference to the views entertained by numerous meteorologists suggests the following definition of climate, *i. e.*, the characteristic weather totality of a region, resulting from the combined effect of all the meteorologic phenomena which influence vegetable production and animal development. This definition suggests the immediate influence of the sum of atmospheric conditions upon the vitality, comfort, and intellectual development of individuals. In truth, no other single factor in the environment of a people is endowed with power to influence their health, material welfare, and future destinies to such an extent as climate. Its molding effect upon character and disposition has been recognized for ages, notwithstanding the fact that essential differences in this respect have been attributable in part to national characteristics. It cannot be denied that the physical condition of the atmosphere, with its direct effect upon the flora and fauna of any region, establishes to some extent the nature of industrial pursuits, determines to a degree the character of physical and intellectual development, and profoundly modifies racial peculiarities.

Convincing testimony as to the unfailing influence of climate in stamping characteristic differences upon the same people amid diverse atmospheric conditions, is found in a comparison of the predominating qualities exhibited in remote localities by a single race. Differences of character displayed by the northern and southern inhabitants of Germany, Russia, Spain, France, Italy, and China, to which Huggard has called attention, are paralleled by the exhibition of similar modifications of development and disposition between the northern and southern people of the United States.

History is replete with instances of unsuccessful effort in the way of colonization in strange climates, although the initial conquest was irresistible, the subsequent occupation unopposed, and the reinforcement of population continuous. Failure of racial acclimatization, even

after the lapse of several generations of endeavor, has resulted to a great extent, from inability of nations to adapt themselves to weather conditions, markedly dissimilar to those to which they have been accustomed.

The combined atmospheric phenomena commonly described as weather, bear reference chiefly to variations of heat and cold, moisture and dryness, the direction and velocity of the wind, atmospheric pressure, and the amount of sunshine. These attributes of climate, which are of especial importance to students of phthisiotherapy and climatology, are the result of such causative factors as latitude and altitude, the character of the soil, rainfall, extent of frost, and the distribution of air-currents. From the standpoint of the physician, it is unnecessary to dwell even briefly upon the underlying influences responsible for the *creation* of the various atmospheric conditions. Interest centers more particularly upon the several constituent attributes of climate, and their effect upon physiologic functions of the body. Such inquiry is more pertinent to the purposes of climatotherapy than is a detailed consideration of the many fundamental agencies involved in the production of climate.

Among the climatic attributes capable of exerting a profound influence upon the animal organism, a place of some importance by popular accord has been assigned to the *chemic and bacteriologic purity* of the air. Insistence upon chemic purity of the atmosphere as a *sine qua non* for the health of individuals, presupposes the idea that the actual composition of the air is subject to considerable variation in different locations. This notion as to differences in the relative amount of oxygen, nitrogen, carbonic acid, and other ingredients has been found to be erroneous, save in relation to *confined spaces*, where the complete diffusion of gases is prevented and the influence of wind is altogether absent. By virtue of the latter agencies the *chemic composition* of the atmosphere is subject to almost *inappreciable variation*. This has been demonstrated in the immediate vicinity of large cities, upon the isolated plains, and in close proximity to dense forests. In the neighborhood of populous districts the air is often polluted by *solid* particles of morganic dust. In such localities a potent factor for atmospheric contamination is the emanation of smoke from large chimneys. Bacteriologic impurities, although present to a less extent in the still air of sparsely settled regions, may impregnate the air of the country as well as of the city. While the deleterious effect of chemic atmospheric impurities in ill-ventilated apartments, and of dust contamination or bacteriologic pollution in densely populated districts is too apparent for further comment, the elementary composition of the air is devoid of practical significance with reference to a consideration of climate.

PHYSIOLOGIC CONSIDERATIONS

The utmost interest attaches to a conception of the manner in which the system is affected by the various combinations of atmospheric conditions. In reviewing the physiologic action of the several climatic attributes upon the organism, brief mention will be made of the more important conclusions, which have been recorded as the result of much systematic study by scientific investigators. No deductions will be presented which have not stood the apparent test of patient research and pitiless criticism.

It may be stated as a preliminary postulate that the *chief beneficent action of climate* consists of a *profound influence upon tissue change*, which transcends in importance any primary effect upon the diseased organs of respiration. The potentialities of climate relate not so much to the existence of an atmosphere supposed to be endowed, on account of its freshness and purity, with peculiar virtues for the *purposes of inspiration*, but rather to its presence as a *surrounding medium*, possessing qualities capable of exerting a decided influence upon metabolism. Through the instrumentality of a continuous but irregular *air-bath* a reaction is often established sufficient to modify functional equilibrium. This influence upon the animal functions, which represents the response of the individual to climatic change, determines the measure of the resulting effect upon nutrition, and hence is, in reality, the vital factor in the physiologic problem. Climate then should be studied with reference to changes induced in the stability of functional processes. According as the animal functions are stimulated or impaired, metabolism is influenced for the better or worse respectively.

An important factor in determining the character and extent of alteration of function is the *demand for heat-production*, which fluctuates proportionately with the amount of heat-abstraction. In turn the degree of heat-abstraction varies in accordance with essential differences in climatic conditions. Hence a certain relation is established between the heat-abstracting powers of a climate, and the attainment of maximum nutrition, the sequence of action being the effect of certain climatic attributes in abstracting the heat of the body, the consequent demand for greater production, the stimulation of the various physiologic functions, with increased metabolism and improved nutrition. Evolutionary changes of such satisfying nature are, of course, contingent upon the ability of the individual to respond to the unusual demands for heat-production.

The practical effect of climatic change varies widely according to the vigor of the oxidizing process, this factor in a decision as to the availability of certain climates being even of greater importance than the extent or character of the tuberculous infection. The *personal equation* thus becomes an important consideration in ascertaining the value of the physiologic change in different people exposed to the same climatic conditions. In general, the influence of climate upon nutrition is largely contingent upon the degree of its heat-abstracting capabilities, which feature is defined by Huggard, in his admirable treatise upon the physiology of climate, to be the one fundamental principle of climatotherapy. In view of the fact that the possibilities of heat-abstraction in any climate are dependent upon *temperature* in connection with the modifying influence of *humidity* and *wind movement*, it is well to consider these factors in common.

Despite extreme variation in the physical condition of the surrounding air, the temperature of the body in health remains practically constant. The removal of heat from the organism is subject to great fluctuation by virtue of diurnal, seasonal, and climatic changes, influencing essentially the manner as well as the degree of its abstraction. It follows that a corresponding variation must exist at different times in the working efficiency of the heat-producing apparatus. The non-varying temperature of the body is manifestly not the result alone of a fixed amount either of heat-production or of heat-dissipation, but rather

the balance obtained from a *perfectly adjusted relation of response* to *demand*. Through automatic control of the mechanism involved in heat-production, the supply is regulated precisely by the *expenditure*. Thus the processes of oxidation chiefly responsible for the development of animal heat are directly modified by external conditions affecting heat-abstraction. With increased removal of heat from the body, the peripheral contraction of blood-vessels is accompanied by hyperemia of internal organs, with greater consequent activity of the oxidizing processes engaged in heat-production. Conversely, with diminished loss of heat, by reason of peculiar atmospheric conditions, a compensatory effort is made to favor its removal by an increased functional activity of the skin, with engorgement of the surface vessels and corresponding depletion of the circulation in the abdominal and other internal organs. With lessened heat-dissipation oxidation is retarded and functional activity diminished. If the removal of heat is facilitated, the stimulating effect upon digestion and assimilation is pronounced in accordance with the general law of response and demand. Waiving for the time being the question of personal equation, it may be stated broadly that the increased expenditure of heat is followed by renewal of supply, which is attended by such functional activity as to entail promotion of metabolism and improvement of nutrition. In proportion to the degree of heat-dissipation there is also exerted within certain limits for different individuals, an influence upon the tone of the general muscular and nervous systems. Save in exceptional extremes, the stimulation or impairment of energy varies respectively with the increase or diminution of heat-dissipation.

The removal of heat is not altogether commensurate with the *temperature* of the surrounding air. An important modifying influence is found in the amount of contained *moisture*. With respect to the degree of relative humidity, striking differences are recognized between the physical and sensible temperatures of an atmosphere, which involve corresponding variations in the extent of heat-dissipation. In moist regions common experience attests the raw, chilling effect of moderately cold weather and the relaxing, enervating influence of heat. Upon the other hand, in dry climates, the sensible appreciation of winter cold or summer heat is minimized to a perceptible degree. In cold dry weather the heat is removed chiefly by radiation, which is greatly reinforced by conduction, if the element of moisture is substituted for that of dryness. In warm dry regions the heat is dissipated by evaporation of the perspiration, and to some extent by radiation, both of which agencies are seriously retarded in their action by the presence of moisture in the air. Thus a humid atmosphere, on account of its relatively good conductive qualities, becomes unduly effective in the removal of heat in cold weather, and interferes with evaporation during the hot season, intensifying the uncomfortable effect of both extremes.

The disadvantage of moisture is not confined to its above-mentioned unfavorable influence during excessive heat or cold. It is found, even in the presence of moderate temperatures, that the loss of heat by means of conduction is disproportionate to the actual needs of the organism. Under such conditions the heat-abstraction is often unrestricted by the protecting action of peripheral contraction, and proceeds *beyond the capacity* of the heat-producing apparatus for immediate supply. The chilling effect is further accentuated by the wearing of apparel which, upon satu-

ration with moisture, possesses excellent powers of conduction. Cotton garments, which are good conductors of heat, even in the dry state, derive increased conductivity when moist. In the event that surface constriction be sufficiently prompt to produce internal hyperemia and stimulate the oxidizing processes to greater activity in the production of heat, the conduction becomes ineffective in reducing the surplus, while radiation and evaporation are inoperative by reason of the moisture. In addition to the resulting physical discomfort and sense of inertia, the functional activities are again impaired, oxidation diminished, and derangements of digestion rendered probable, together with reduction of nutrition. Huggard has called attention very clearly to the important difference between heat-abstraction in dry and moist localities, the distinguishing characteristic in dry regions, being the removal of heat by radiation and evaporation in rather strict accordance with the peculiar necessities imposed upon the organism by external conditions. In the presence of moisture, however, evaporation and radiation are hindered and conduction either becomes instrumental in an undue depletion of the heat store, or is inadequate to remove an overabundant supply. Its action, therefore, would seem distinctly embarrassing to the normal physiologic relation between response and demand.

Another important modifying feature in the abstraction of heat is the presence of *wind*, through which agency convection becomes operative. By means of this influence the action of both cold and moisture is greatly exaggerated. The general character of winds is dependent upon the influence of fundamental natural factors. The degree of heat removal and the other physiologic effects upon the organism are, of course, dependent upon the different qualities of the wind. Chilling, enervating, or other disagreeable effects accrue in different places and at varying times, according to direction, force, and duration, in association with temperature, dryness, and the amount of dust held in suspension. The importance of wind in this connection relates chiefly to its action under certain conditions, in modifying the influence of temperature and dryness in the removal of body-heat. It goes without saying that but slight movement of the air is necessary to intensify the effect of cold in winter, or of moisture during warmer seasons. Even in the presence of atmospheric dryness, heat-dissipation is markedly accentuated by wind, radiation becoming more active in cold weather and evaporation in summer.

Evaporation is also increased by the diminution of atmospheric pressure incident to altitude. It usually happens that extreme dryness occurs in combination with altitude and wind velocity. Under such conditions in mountainous districts, heat-abstraction is facilitated by the action of the colder temperature and the increased dryness peculiar to the locality, as well as through the influence of lessened atmospheric pressure and local air-currents of variable intensity. The distinguishing characteristics of such regions are coolness, dryness, rarefaction of air, with its complicated physiologic effect upon the organism, prevalent winds, and *variability* of temperature. Equability of temperature, which is erroneously regarded by some as a concomitant of altitude and dryness, in reality is unavoidably associated with the humid atmosphere of the lowlands.

From the preceding considerations it is seen that equability of temperature *per se* does not necessarily constitute a desirable feature of any

climate, with reference to its intrinsic demands upon the body for heat-production. Its obvious disadvantage in this respect is greatly augmented by its close, unavoidable relationship with atmospheric humidity. As has been pointed out by Huggard, equability of temperature in association with moisture does not produce regularity of heat demands upon the physiologic apparatus for heat-production, but, upon the contrary, does effect such *variability* of expenditure, out of proportion to the needs of the body, as to embarrass seriously the mechanism for supply. Upon the other hand, through the influence of dryness, variability of temperature is capable of producing in general only such abstraction of heat by means of radiation and evaporation, as will result in an adaptation of the organism to these external factors. It is, therefore, important to distinguish between the *equability* of temperature in a climate with *variability* of heat-dissipation, and an *adaptability* of the *body* to *irregularity* of heat demands in a *variable* climate.

The vital consideration in determining the ultimate effect upon metabolism and nutrition, is the response of the organism to the influence of the external factors engaged in the removal of heat. The degree and character of the response are subject to considerable variation by reason of existing conditions peculiar to the individual. Thus, identical attributes may induce extremely diverse reactions in different people. This feature, therefore, constitutes a factor of great importance in defining the general effect of climate upon individuals. Thus, the stimulating effect resulting from the removal of body-heat is contingent upon the capabilities of the individual to respond to the increased demand. Change of climate may be beneficial or injurious not solely in accordance with the nature of strange external conditions, but as well with the degree of adaptation of the individual to the new climatic environment. It is important, therefore, to adjudge the value of climate from its relation to the invalid in question, rather than from an abstract consideration of its intrinsic qualities. Further, the merits of widely differing climates for the pulmonary invalid, should be decided with reference to the *general fitness* of the individual, rather than from arbitrary considerations pertaining alone to the pathologic condition. Suggestions will be presently made as to the relative importance of the individual factors involved, as well as to the general principles to be observed in the selection of climate.

While the removal of animal heat through the influence of external conditions, represents perhaps the most important physiologic action attributable to climate, *other reactions* of great interest to physicians have been found to take place as the direct result of *diminished atmospheric pressure*. A vast amount of research relative to the effect upon the body of exposure to rarefied air in high altitudes, has been conducted by many distinguished German, French, and Italian physiologists following the publication of the admirable monograph of Bert in 1878. It is possible, within the limits of this chapter, to review but briefly the general conclusions, which, developed as a result of their systematic study, may be regarded for practical purposes as free from error. While it has been demonstrated that nearly all functions of the body are influenced more or less by residence in high altitudes, a few physiologic facts have been established, which are far reaching in their significance. Zuntz, Loewy, Muller, and Caspari have recently called attention to the influence of lessened barometric pressure in high

altitudes upon *tissue change*. It has been shown that nitrogenous material is assimilated with greater ease in moderate altitudes, especially under conditions of physical exercise. The stimulation of proteid metabolism is found to take place even in slightly elevated regions of from 1000 to 2000 feet, although more pronounced in the higher altitudes. In extreme elevations the process is reversed, the height of the turning-point varying in accordance with the peculiarity of the individual. It thus appears that the degree of rapidity of the oxidizing processes results not directly from the amount of oxygen supplied at different altitudes, but rather from the increased demand of the tissues by virtue of associated climatic conditions.

Dr. Henry Sewall, in interpreting some of the observations and experiments bearing upon the *relation of oxygen tensions in the air and in the blood*, has called attention to the fact that, under ordinary conditions of life, there is contained in the blood far more oxygen than is actually required for the performance of metabolism. The weakness of the bond of union between the oxygen of the blood and the hemoglobin of the red corpuscles is well known, but the effect upon this combination of diminished pressure at moderate altitudes remains somewhat unsettled. It is doubtful if variations in the capacity of the blood to absorb oxygen at different elevations are sufficient to explain the development of functional disturbances commonly attributable to altitude. It is clear that the element of *time* in connection with *physical rest* constitutes the all-important consideration in the adjustment of the organism to diminished pressure. In this event the system apparently suffers no embarrassment from any supposed effect of the lowered barometric pressure upon the combination of oxygen with the hemoglobin.

A practical unanimity of opinion has been recorded by all observers as to the influence of altitude upon the *absolute number of red blood-corpuscles*. There is uniformly noted an immediate increase in the blood count upon ascending to a higher level, but opinions are very conflicting as to the interpretation of this fact. Definite substantiation is lacking for the alluring theory that the deficiency of the oxygen in the air is compensated for by an increase of oxygen in the blood through stimulation of the blood-making apparatus. Certain it is, however, that the red blood-corpuscles are actually increased in number in high altitudes, and also that the amount of hemoglobin is augmented very appreciably. The apparent effect of lowered atmospheric pressure upon the blood-forming apparatus is of much interest in connection with the stimulation of metabolism.

Studies of *variation in blood-pressure* at different altitudes have generally resulted in harmonious conclusions as to the fall of arterial pressure with increasing elevation. The diminution of pressure is usually exaggerated by physical exercise, which also exerts a significant influence upon the pulse-rate. Upon removal to high altitudes the latter is noticeably accelerated, and upon exercise becomes disproportionately more rapid and weak than at sea-level. This influence of diminished atmospheric pressure upon the pulse has been shown to be subject to great variations in individual cases, and under proper conditions of management to be susceptible of adjustment, provided the system is not crippled too seriously by disease. The results of Sewall's observations upon venous blood-pressure in Denver show a positive increase at a level of 5280 feet as compared with sea-level.

In general, the *respiratory rate* is accelerated in proportion to the diminution of atmospheric pressure. The depth of the respirations is also increased under similar conditions. A certain amount of vesicular dilatation takes place from the increased tension in the alveoli as a result of the more pronounced inspiratory efforts. Increased circumference of the chest, however, from continued residence in mountainous regions is not associated, as a rule, with increased vital capacity. Here, however, the question of individual adaptation constitutes an essential feature, the character of the respiratory excursion and the degree of alveolar dilatation being subject to much variation.

The influence of diminished atmospheric pressure upon the *nervous system* is at times marked in different individuals according to the degree of their adjustment to changed barometric conditions, and their response to the increased demands for heat-production. The nature of the effect upon the nervous system is, therefore, dependent to some extent upon the accompanying change in metabolism and nutrition. According to the adaptability of the individual and the influence of all the climatic attributes upon the general tone, the resulting action upon the nervous system may be described as either stimulating, or irritating and exhausting. The bracing, invigorating effect is undoubtedly caused by the enhancement of tissue change, the stimulated activity of the heart and lungs, and the influence of the intense solar heat and illumination upon the skin. It may be stated parenthetically that profound physiologic effects are produced by the influence of sunlight. In dry, elevated regions the sunlight is abundant, prolonged, and intense, the number of cloudy days being comparatively few. On account of the slight amount of moisture in the air, the radiant heat of the sun is much greater than the temperature of the air. But little intervening moisture is present to absorb the heat, and marked differences of temperature are appreciated between the direct sunshine and shade, as well as between day and night. As a result of the diathermancy of the air, the therapeutic value of the sunshine is undoubtedly enhanced to some extent.

Irritability with functional exhaustion sometimes takes the place of exhilaration. Among individuals with unstable nervous temperaments there may ensue restlessness, overstimulation to physical exertion, insomnia, or impairment of mental energy and depression. While admitting the not infrequent exhibition of these unfavorable symptoms strictly among neurasthenic patients, it is desired to emphasize the conviction, as stated in a previous chapter, that exaggeration of such nervous manifestations is not entirely referable to the effects of altitude. In many instances associated conditions pertaining to the environment and method of living are responsible, to a considerable extent, for the development of nervous disturbances. It is not altogether the actual elevation above sea-level, but the *knowledge* of the change of altitude and the *anticipation* of abnormal sensations that determines the character of subsequent symptoms. Clinical experience in Denver has shown that the expectation of a disturbed nervous equilibrium on the part of the patient has often represented an important agent in the development of nervous symptoms, which in turn have disappeared upon proper reassurance and the inauguration of a suitable régime. It is, nevertheless, true that among a comparatively small class, disturbing nervous influences are actually exerted upon

arrival in high altitudes. Unpleasant effects often disappear, however, as a result of the progressive adjustment of vital processes to changed conditions through the influence of rest. The appropriateness of moderate degrees of altitude for the various classes of pulmonary invalids will be presently discussed.

In concluding a review of the physiologic action of certain climatic attributes upon body functions, it is fitting to submit, as a logical sequence of thought, the general proposition that climate may fail to render its beneficent aid to the unfortunate consumptive only when the victim of the disease indulges in fatal procrastination, errs grievously in climatic selection, or rejects *in toto* the accompanying advantages of a suitable régime. Applying the principles of deductive logic to the established action of atmospheric conditions upon the organism, it seems impossible to deny the benefits accruing to pulmonary invalids from subjection to the immutable influence of appropriate climates.

CLINICAL TESTIMONY

The second affirmative proposition relative to the claim of climate as a therapeutic agent, consists of the accumulated mass of clinical evidence in substantiation of its value. For obvious reasons it is well-nigh impossible to compare satisfactorily the results observed in climatic resorts with those reported from sanatoria in unfavorable regions. Attention has been called to the vastly differing conditions obtaining in the so-called favorable climates and in local sanatoria for incipient cases. Statistical observations for comparative purposes are, indeed, of doubtful efficacy, unless conditions aside from climate are practically identical. In analyzing the results obtained in different localities, the opportunities for error are so numerous, as to vitiate completely any conclusions which are based alone upon statistical investigation. Recourse, therefore, must be taken to the ripe experience of trustworthy clinicians, who have been privileged to enjoy ample opportunities for observation and are thus qualified to entertain judicial opinions. The evidence in favor of climate derived from such non-partisan sources has been found so irrefutable as scarcely to warrant repetition.

Strangely enough, even the most bitter opponents of climate are wont to display unconsciously marked inconsistencies of precept as well as of practice. An eminent authority, in a recent book upon "Pulmonary Tuberculosis," places himself upon record as ardently opposed to the current idea as to the efficacy of climate, only to retract, in later pages, through numerous admissions, regarding its many desirable features. In the section of his book devoted to climate general negative propositions are advanced, as shown by the following brief extracts: "This deeply rooted idea of the necessity of change of climate for all sufferers from pulmonary tuberculosis is erroneous on the face of it. . . . Sanatoria have been built in many parts of this country and of the whole civilized world. Their climates are of almost every description, yet their results are similar. Their success in no way depends upon their elevation, upon their proximity to the sea, nor upon any quality possessed by the air of their locality. Speaking from a close observation of a number of patients, who, after undergoing a course of sanatorium treatment at home, subsequently sought various distant health resorts, I can assert that in no single instance was the progress of the disease distinctly affected by the change of climate. In the case of patients

who were doing well at home, recovery appeared to be in no way hastened by the influence of a selected climate abroad. In the case of patients who were doing badly in this country, a removal to a recognized health resort did not succeed in arresting the downward progress." The untenability of the position assumed is made apparent by his following statements, which in relation to the above appear quite equivocal. "We like the treatment to be carried out in a locality whose air is pure and bracing, but moderately dry. It is possible that the more fully the climate possesses these qualities, the more rapid will be the recovery of the consumptive. . . . Theoretical considerations tell us that the air of towns is not favorable, and there is every reason to believe that recovery is expedited by placing the patient in pure, uncontaminated air. . . . In the same way as regards other qualities of the air the majority of consumptive patients are benefitted by a bracing air. In so far as the appetite and other vital processes are sensibly quickened in a bracing climate, there must be an advantage in conducting the treatment in such an air. . . . I would only say, in regard to excessively moist conditions of the atmosphere, that while most consumptives are unaffected, a certain small number find that their coughs and difficulties of breathing are increased. . . . In regard to soil we are probably right when circumstances afford us a choice in selecting one of gravel or sand. . . . It will be seen, therefore, that a pure and bracing air, with a dry, warm soil and free exposure to sun, are of relative advantage. . . . A large rainfall makes the open-air life less easy. . . . Sunshine in general acts as a germicide and must, therefore, have a beneficial action upon the patient's atmosphere. . . . It is generally agreed that better results are obtained in sanatoria during the winter than in the summer. The majority of our consumptive patients tell us that they are better suited by cold than by hot weather. . . . Patients whose pulmonary tuberculosis is of the catarrhal type, with much bronchitis or perhaps with emphysema and asthma, often respond well to open-air treatment, but they are susceptible in the matter of climate and do better in one locality than in another. . . . In the case of patients who are able to indulge themselves, by all means let us allow them to pass the winter where the open-air life can be followed with the greatest amount of comfort and pleasure."

Despite the derogatory character of the opening statements relative to the rôle of climate in the treatment of tuberculosis, no stronger subsequent indorsement of its influence could be asked even of its most active supporters. The conclusions expressed are eminently rational, and in line with the opinions long entertained by all climatotherapeutists, but are, nevertheless, strongly contradictory to the introductory assertions. It so happens that a great majority of the assailants of climate are responsible in their writings and actual practice for similar inconsistencies. In the language of Dr. F. I. Knight, "If weather conditions make no difference, why do patients improve so much more at one season than at another? If it makes no difference, why are all of us so anxious to get our patients a residence upon dry soil, with a sunny exposure and protection from the strong winds?" "If sunlight is good at all, why is it not better to have twenty-five or more days of it per month than to have ten or twelve or less?"

It is, indeed, difficult to comprehend how any negative argument

can develop concerning the great value of climate in the treatment of consumption, provided there is instituted a proper selection of cases and a conjoined attention to mode of life. If the doctrine of outdoor living means anything as directed toward the pulmonary invalid, it means that the best results are to be obtained through its most complete fulfilment. It follows that the fullest conception of a proper method of open-air existence can be satisfactorily conducted only in those regions affording the maximum amount of sunshine, with associated warmth, dryness, and rarefaction. If a suitable régime alone is capable of producing a perceptible improvement in incipient cases, how much greater and more enduring results, among a larger number of cases, advanced though they be, may be obtained by precisely the same manner of life, plus the beneficent influence of climate. It appears that a far more improved mode of life can be enacted in an appropriate climate, than in less favored regions, by reason of the added opportunities for outdoor living. If a system of regimen, necessarily incomplete in moist, cloudy regions, is good, a well-nigh perfect adherence to these principles, in a land of perpetual sunshine, invigorating air, inspiring scenery, and blue sky is certainly better. May it not be asserted, therefore, that a consistent regard for the very principles upon which depend negative claims, necessarily carries with it an almost incontrovertible argument in favor of climatic change for a large number of cases?

It must be insisted that there is something in climate entirely apart from these factors of sunshine and dryness incident to favorable regions. If to these attributes be added diminished atmospheric pressure, there are exerted certain intrinsic influences, distinctive of the locality, markedly favoring the attainment of satisfactory results. Reference is made to the increased metabolism from the more perfect system of heat-abstraction, and the general stimulating effect upon the muscular and nervous systems. In addition, the influence of altitude in wisely chosen cases has been shown to produce an increase of red blood-corpuscles and hemoglobin, to promote vesicular dilatation, to effect improvement in the vigor of the circulation and respiration, and to involve digestive and nutrient changes of vast import.

Aside from such considerations as the foregoing, may be mentioned the value of the psychic element involved in all changes of residence. This may react for good or evil according to the sagacity displayed by the medical attendant. Admitting a proper selection of cases and provision for a suitable environment, there may develop factors of no little value in the novelty of new surroundings, change of food, scenery, custom, companionship, the relief from cares and responsibilities at home, and all the interest that attaches to a new country, with its stir and energy. The good results obtained in unfavorable localities among early cases do not constitute an argument against the greatly increased benefits to be derived by a much larger class of patients, as a result of the same watchful observation in an appropriate climate. Many instances of enduring arrest have taken place among patients for whom a rigid adherence to sanatorium régime was utterly impossible. A very considerable proportion of the invalids observed in health resorts are financially unable to observe a strict system of daily living. By virtue, however, of pronounced climatic advantages, they are permitted to perform light work, and at the same time to secure a marked prolongation of life, or an eventual arrest of the disease.

Recognizing the comparative rarity with which consumption has originated for generations in the midst of certain climatic conditions, the relative frequency of its development and the rapidity of its progress in other places, it should follow, as a logical sequence, that climate must take its place as an important factor in subsequent efforts to secure arrest. It should be borne in mind that a few climates still exist where tuberculosis is very rarely indigenous in spite of the existence of some factors that might reasonably be expected to produce an increase of native cases. It is apparent that there are offered to pulmonary invalids better facilities for improvement in the midst of influences which have prevented the development of the disease in others, than under exposure to the same conditions that have been conducive to its origin at home. The same process of reasoning may be extended in its application to the more *remote future* of the consumptive. This leads inevitably to the conclusion that the individual, "once a consumptive, always a consumptive," possesses the inviolable right to be placed, if possible, in the midst of a new and more advantageous environment. He should be afforded the greatest degree of protection against renewed tuberculous activity, and offered, at the same time, in addition to opportunities for recreation and social advantage, facilities for industry and business enterprise. In the midst of an active civilization in favorable climates the invalid may be permitted to engage eventually in a useful and prosperous career.

This course of remark is presented merely as an appeal for an impartial consideration of the subject in the interests of the invalid alone. The contention is made that while *some* cases may be expected to do well under proper supervision, *even if deprived* of the advantages of climate, and that *others* are *inappropriate* for such change, yet an enormous class is justly entitled to receive its benefits.

CASES APPROPRIATE FOR CLIMATIC CHANGE IN GENERAL

It is hardly necessary to define in detail the character of cases embraced in this general class. A somewhat broad and comprehensive grouping of those for whom some climatic change is indicated includes—

1. All those with moderate infection, who are not prevented from leaving home by financial embarrassment or other equally cogent reasons.

2. Those in a similar physical condition, though with but a meager monthly allowance, provided sufficient accurate information is obtained in advance concerning suitable accommodations at an expense within their limits.

3. Those admittedly dependent upon their own efforts for support, but, nevertheless, with such slight pulmonary involvement as to permit the performance of outdoor work in some favorable region where employment may be assured.

4. Those with considerably more advanced trouble, but favored by a cheerful, sensible temperament, affluence, determination to succeed, an abiding hope with desire for climatic change, a ready compliance with instructions, and an apparent easy adaptation to new surroundings.

That this grouping of cases, subject to qualification according to modifying individual factors, is reasonably correct has been shown by experience in favorable localities where remarkable results are often

obtained in advanced cases, and among those with exceedingly limited resources.

It thus follows that upon the basis of actual results, an assuring welcome may be extended to some who are no less worthy, if less fortunate, than their fellows in their equipment and opportunities. It must not be understood, however, that those hopelessly ill or utterly impoverished should be encouraged to seek climatic change. For these, the erection of State and municipal sanatoria along lines elsewhere suggested is obligatory, practical, and economic.

Class 1.—In explanation of the somewhat arbitrary and comprehensive grouping of cases with moderate infection and a comfortable financial status, it should be borne in mind that the essence of this particular phase of the subject relates exclusively to the *best possible* provision to be made for such cases. An enormous class, who are intensely anxious to avail themselves of every rational opportunity to recover from their disease, appeal to their medical advisers for nothing less than that which affords the maximum assurance of ultimate recovery. Cases such as these, willing to engage in the prolonged struggle which is destined so frequently to be a test of their fortitude, with restoration to health as the vital issue, surely deserve such favorable facilities as will insure the greatest probability of final success. The obligation of the physician is not fulfilled by advising merely what is admittedly good, but is only discharged by urging what is actually the very best for the individual case. It is not a question of the possibility of securing arrest at home or within a local institution, but whether such an environment of itself is the method *most likely* to accomplish this result. The physician, in assuming to direct the destinies of his well-to-do consumptive, should make a practical application of the condition to himself and advise in accordance with the course he would pursue under similar circumstances. When such is the case, little doubt can exist as to the promptitude and certainty of action. The sweeping assertion, therefore, that patients of this class should be permitted to enjoy the benefits of climatic change, is based upon the fundamental principle that these individuals possess an indisputable right to receive that early unrestricted consideration and advice, which an actual experience has demonstrated to be the safest and most conservative.

Class 2.—This division embraces the large middle class, with moderate infection, but limited finances. Such patients, though greatly handicapped by lack of means, are not absolutely impecunious, and in many instances not dependent for support upon themselves alone. It frequently happens, that relatives are enabled to render such assistance that, by the practice of rigid economy, the patient is offered definite assurance of improvement from an inexpensive sojourn in a favorable climate. It is absolutely essential, however, in justification of such change, that authentic information should be secured in advance as to the actual expense necessary to provide appropriate accommodations. The question must be plainly reviewed with the patient and family in all its phases, according to the individual conditions in force. Decision as to climatic change must be made strictly upon the special merits of the physical condition and attendant circumstances. Experience has shown, over and over again, that a limited financial status is no insuperable barrier to recovery in health resorts, provided there is instituted a wise preliminary guidance and subsequent supervisory direction. The real

solution of the problem for these people consists of the opportunities at their disposal in favorable regions. The position of the medical attendant in advising a journey to a distant clime for such patients is fraught with much responsibility. A justification, however, for this course is found in the definite knowledge of the ready facilities for their reception within the bounds of their limited resources. Admitting such provision, there can be no argument as to the expediency of offering to this class reasonable opportunities for securing a restoration of health and resumption of earning power.

Class 3.—This group embraces individuals who, although to a great extent dependent for support upon their own efforts, are, nevertheless, in such physical condition as to justify light outdoor employment. The practical consideration obtaining among such patients, is the fact that the performance of work is more or less *obligatory, irrespective* of their location. This being true, it is obvious that their chances for recovery are materially enhanced by residence in favorable climates. For these people the observance of a suitable régime is quite out of the question, and if work they must, it is eminently desirable that employment be secured under the most advantageous circumstances. It has been demonstrated repeatedly that a large proportion of incipient cases without expectoration, or bacilli, now frequently admitted to local sanatoria, constitute but little danger to the community, and yet with slight financial assistance in an appropriate climate are not too ill to engage in some occupation with a reasonable assurance of improvement. Such a happy result is far less likely to attend their continuous struggle for existence amid unfavorable surroundings.

Class 4.—This group comprises patients who, though suffering from advanced infection sufficient to render prognosis doubtful in any climate, nevertheless are endowed with favorable temperamental conditions and adequate resources. The necessarily prolonged separation from family and relatives, the knowledge of the grave possibilities, and the physical discomfort, in many cases, would influence a deciding vote against the hardships of an extended journey, were a welcome extended to such individuals by sanatoria nearer home. In view of the inability of patients of this class to gain admission to closed local institutions, almost the only remaining hope is from climatic change. The actual proposition to be faced by patients is the fact that they have but little to lose by recourse to this move, and perhaps everything to gain. Conversely, after a progressive decline throughout a prolonged period at home, they have no valid reason to anticipate better results in the future than in the past under the same conditions, hence every rational incentive for a sanely directed climatic change. It is but fair to state that this should not be decided upon without a frank recital of the situation to the patient and friends, and a full appreciation, on their part, of the utter uncertainties. Neither should it be undertaken without provision having been made to permit the subsequent elaboration of an intelligent régime. Attention has been called in previous pages to the remarkable results sometimes achieved among patients concerning whom no reasonable hope for recovery could be entertained at the time of arrival.

It is important to emphasize the folly of sending hopelessly advanced indigent patients to health resorts. While well-to-do desperate cases are not of necessity debarred from the possibility of final arrest after

several years of patient endeavor, destitute consumptives similarly afflicted are not offered the same opportunities for securing arrest. The interests of such patients are in no wise subserved by sending them to a far country to battle against great odds among strangers and often amid grossly unfavorable surroundings. While the physicians and philanthropic citizens of open health resorts are ever ready to lend their aid to worthy impoverished consumptives, the fact remains that it is no kindness to send such cases away from home. Furthermore, it must be remembered that the influx of phthisical patients in all stages of the disease and in direst financial distress, constitutes an economic problem not to be ignored by the inhabitants of climatic resorts. A large class of advanced pulmonary invalids, with no conception of their individual needs, are compelled to struggle for a livelihood in order to supply the most pressing necessities of life. Others are doomed to disappointment in securing work, and either are obliged to seek assistance in order to return home, or become a charge to the local community. Serious hardship is sometimes inflicted upon the resident employé and his family in being forced to compete with the cheap labor of the unfortunate consumptive. The presence of hopeless consumptives in a community often tends to inculcate public pessimism as to the possibility of ultimate arrest, and to retard charitable impulses for the relief of those less seriously afflicted. As a rule, the advanced consumptive with extremely limited resources does not profit from the hardships necessarily assumed by himself, as well as imposed to some extent upon others. Allusion is made to those of his family who, by dint of personal sacrifice, manage to extract a mere pittance from their savings in order to contribute toward a portion of his support, or who assume obligations representing a grievous burden to be borne through many years. In view of the indiscriminate character of the patients, who seek relief in health resorts after months or years of unnecessary delay, it is no wonder that resident physicians are clamorous in their demands for an earlier appreciation of the importance of climatic change, and for the display of added care in determining the suitability of the individual to the locality.

CONSIDERATIONS RELATIVE TO CLIMATIC SELECTION

In the course of the preceding remarks, an effort has been made to emphasize the importance of a discriminating choice of climate according to the physiologic adaptation of the individual. It has been made clear that no single locality is appropriate for all classes of pulmonary invalids who may demand, upon the merits of their condition, some form of climatic change. Many consumptives exhibiting similar physical signs and subjective symptoms differ essentially in their constitutional vigor, while some present certain important complications. Thus, among patients apparently in the same class, marked differences exist in the indications for climatic selection. Often the decision with reference to radically diverse types of climate should be influenced by the age of the pulmonary invalid, the previous habits, environment, race, temperamental peculiarities, and complications. Climates which for many individuals exert a general stimulating and tonic action are found to produce pronounced irritability or depression in others. *Per contra*, certain regions noted for their enervating and relaxing influence upon

the majority of pulmonary invalids are found to exercise a soothing and bracing effect upon some with disturbed nervous equilibrium. Thus it follows that the selection of climate for those suffering from pulmonary tuberculosis should be based primarily upon an intelligent conception of the *constitutional requirements* of the individual. There is demanded an accurate knowledge of the damage already wrought by the destructive process, and a working familiarity with the atmospheric conditions in force at the various health resorts and their physiologic effects. A not unimportant factor is the nature of the accommodations available for patients in different localities. In addition to the facilities for the proper reception of cases, some importance may attach to the general character of the medical supervision in different resorts. In many instances determining features relate to the opportunities offered for diversion and recreation, social advantages, educational facilities, and industrial pursuits. The above considerations may sometimes turn the scale in favor of a locality exhibiting climatic virtues in no way superior to those possessed by other resorts embraced in the same general region.

Of all the several factors worthy of thoughtful review, none is more important than the degree of individual response to the heat-dissipation, which is subject to great variation in different localities. It has been stated that the abstraction of heat is most efficient in moderately cold, dry, and variable climates in elevated regions. In mountainous districts a certain disadvantage attaches to the occasional high velocity of the wind and the presence of dust, but these conditions do not offset the high value of the combined climatic influence upon metabolism. While in general the most favorable climate for consumption is that exhibiting attributes of dryness, sunshine, moderate altitude, diminished atmospheric pressure, and variability, this combination in its physiologic demands upon the organism is not suited to the needs of *all* patients. The occasional lack of adaptation has led to repeated assertions that dry, cool mountain climates are appropriate only for patients in early stages, with robust constitution and slight, if any, functional impairment. At the same time the contraindications for residence in moderate altitudes, as laid down by various writers, are legion. Many statements of this character are scarcely in accord with the results of experience. It is true that patients with incipient infection, endowed with sturdy and vigorous constitutions, without other organic derangement, do particularly well in high altitudes. In such cases the response of the organism to external atmospheric conditions is usually immediate, despite indulgence in moderate physical exercise. In addition, a large class, with a perceptible reduction of vitality, disordered digestion, and defective assimilation, often evince, under conditions of rest, a degree of response far beyond the anticipation of medical advisers. This capacity for favorable reaction occurs in many instances in the presence of extensive damage to pulmonary tissue. On the other hand, persons with extremely low vitality, enfeebled circulation, and greatly impaired digestion, when exposed to such climatic conditions, often suffer an aggravation of the functional derangement.

It follows that low elevations and equability of temperature, with varying degrees of moisture, are admirably suited to the needs of a considerable class, irrespective of the duration or activity of the tuberculous process. These climatic attributes, in connection with warmth, may

produce among some patients a stimulating effect upon the general system, with promotion of metabolism and nutrition. As a rule, patients displaying excessive destruction of pulmonary tissue, resulting in marked diminution of respiratory capacity, thrive only in warm, dry regions having a high barometric pressure. Many sufferers from dry bronchitis, asthma, and extensive emphysema demand not only residence at low elevations, but also the added elements of equability and moisture.

Generally speaking, the young show a much greater adaptability to mountainous climates than the aged. At the latter extreme of life the vitality is diminished, the cardiac force weakened, the circulation enfeebled, and the walls of the arteries likely to be more or less thickened. For such patients the climatic needs consist of warmth, equability, and absence of elevation, even if there is considerable moisture. In the same way persons in middle age, who for prolonged periods have been the victims of perverted metabolism, may exhibit such pathologic change in the heart, arteries, and kidneys as to preclude subjection to the cold and variability of temperature incident to high altitudes. For these people, with declining powers of heat-production, caution should be exercised, because of their inability to respond to the increased demands.

It is, of course, recognized that advanced degenerative changes in the heart, arteries, or kidneys must disparage recourse to the cold, dry air of elevated plateaus. It does not follow, however, that the existence of all forms of organic heart disease, regardless of their character or degree of compensation, necessarily prohibits residence in moderately elevated regions. It is often impossible, in a given case, to estimate with any degree of accuracy the probable effect of low barometric pressure upon the heart. Patients with well-defined valvular lesions, but with adequate compensation, frequently show no symptoms whatever upon ascending to very elevated regions. Upon the other hand, individuals disclosing upon examination no evidence of organic change, occasionally exhibit disturbed cardiac function at an altitude of from 6000 to 8000 feet. It would appear that the vital consideration is not a refinement of diagnosis relative to the existence of an obscure, perfectly compensated valvular lesion, but rather an attempt to judge, as closely as possible, concerning the relation of heart power and work. It is apparent that flabby, dilated hearts, pronounced myocarditis, even without dilatation, and acute inflammatory conditions involving the endocardium or pericardium, should debar patients from visiting mountainous regions. In cases with uncomplicated regurgitant lesions or with moderate arteriosclerosis, admitting of reasonable doubt as to the advisability of change to moderate altitudes, tentative recourse to slightly elevated regions represents a judicious and conservative course.

Consumptives suffering from advanced kidney disease are unsuited for high altitudes, and, in fact, inappropriate for climatic change of any kind in the hope of securing appreciable prolongation of life. It is important, however, to refrain from rendering an unfavorable prognosis upon the basis of a simple albuminuria. In this connection the following case is of some interest:

A man, twenty-seven years old, a patient of Dr. Biggs, with tuberculous family history, consulted me November 11, 1895, immediately upon arrival in Colorado. His illness had developed in November, 1893, following a severe attack of grip. He spent a large portion

of the following year in the Adirondacks, and exhibited material improvement in all respects. Upon coming under my observation the nutrition was but slightly impaired, and the general condition excellent. There were signs of consolidation, however, in the left upper lung, with moist râles from the apex to the fourth rib and to the middle of the interscapular space. The examination of the urine disclosed a large amount of albumin, without casts or other abnormal sedimentary findings. There was displayed, however, a remarkable diurnal fluctuation in the amount of albumin. The urine, taken at different hours of the day, was frequently examined, and while albumin was found to be present in variable amount in each specimen, the quantity in many instances represented but a slight trace. The albuminuria, after persisting for nearly a year, disappeared altogether, and has not returned during a residence of twelve years in Denver. The patient secured a complete arrest of the tuberculous process and has been engaged in an active business career.

Even the presence of hyaline and granular casts, with or without a slight amount of albumin, is insufficient to warrant an unreservedly bad prognosis. The recognition of hyaline or granular casts in persons beyond the prime of life is by no means uncommon, while among younger people an irritative, rather than a purely degenerative, process may be suggested in some instances. As a rule, the early stages of chronic interstitial nephritis among pulmonary invalids indicate the advisability of equability, dryness, and high atmospheric pressure rather than residence in mountainous districts. While a certain number of nephritic consumptives may be expected to yield indifferent results if exposed to the variability of temperature incident to higher altitudes. a few are found to improve satisfactorily in dry, moderately elevated regions.

It is frequently urged that residence in high altitudes is contraindicated for the consumptive by the coëxistence of such nervous disturbances as severe and protracted headaches, insomnia, irritability, and hysteria. The reason adduced is the supposed resulting aggravation of the nervous symptoms, and the consequent unfavorable influence upon the course of the tuberculous infection. The inference is implied that improvement in the nervous derangement must precede any change for the better in the lungs. This is not invariably the case, although upon general principles it is wise to maintain as perfect a nervous equilibrium as possible. In the majority of cases the acquirement of an *increased* nutrition must antedate any appreciable progress either toward the arrest of the tuberculous process or the alleviation of functional disturbance. The reported observations of Dr. H. T. Pershing, of Denver, which coincided with the published views of the late Dr. Eskridge, indicate the slight influence of altitude upon purely functional nervous disorders. With this opinion, my own experience relative to nervous disturbances among pulmonary invalids accords somewhat closely. It has not been altogether uncommon, however, to note an aggravation of neurasthenic tendencies, *apparently* the result of altitude, but these manifestations have been chiefly observed amid an *unsuitable environment.* While pronounced nervous disturbances offer a serious obstacle to improvement in any climate, the pulmonary infection must be regarded as the paramount issue, the functional derangement demanding greater attention to details of management rather than change of climate. Among neurotic invalids residing in high altitudes,

the psychic influence attending change of immediate surroundings, without the slightest difference in climatic conditions, is often productive of remarkably gratifying results. It is true, however, that many neurotic invalids are likely to reflect greater credit upon the therapeutic management, if subjected to the soothing sedative influence of warmth, moisture, and equability.

Fever is sometimes regarded as an important consideration in a decision as to a choice of climate, high altitudes being supposed to exert a deleterious influence. If other conditions are not distinctly contraindicative of climatic change, the presence of fever greatly emphasizes the expediency of such a move. No greater folly can be exhibited than the practice of waiting for the fever to subside, under the mistaken notion that residence in favorable regions will produce an increase of the temperature elevation. An important factor in the reduction of fever is the maintenance of complete rest in the open air during as many hours as possible. The elaboration of such a system of living must be more complete in localities permitting the maximum amount of sunshine. It follows that the essential consideration in such cases is the avoidance of any unnecessary delay in the selection of climate in accordance with the manifold phases of the case.

Excessive bronchial irritation also is regarded by some as a contraindication for sojourn in high and dry climatic resorts with variable temperatures. Occasionally this annoying manifestation is temporarily aggravated in elevated regions, but the possible irritative effect upon the bronchial mucous membrane is by no means a criterion of the precise influence of the climate. The efficiency of the latter is measured solely with reference to the subsequent course of the tuberculous process, which is the only consideration of especial importance. The bronchial irritation in such cases is often of minor significance, and in nearly all instances is susceptible of decided amelioration under a proper régime. Only when this condition is associated with or dependent upon extensive pathologic changes involving the pulmonary or circulatory apparatus, which in themselves suggest the advisability of warm, equable, and moist climates, are moderate altitudes contraindicated.

Pulmonary hemorrhage, popularly supposed to furnish a contraindication for residence in elevated regions, is less likely to ensue in such places than at sea-level, provided departure from home is delayed until a brief interval has elapsed after the hemorrhage has ceased.

This subject has been discussed in some detail in connection with Symptoms.

In general, it may be assumed that the special contraindications for sojourn in elevated regions are not so numerous and urgent as some have been led to believe.

POPULAR LOCALITIES

Professor Moore has stated, "Within the broad confines of the United States there are many, but not all, shades and varieties of climates." A diversity of climatic conditions is inevitable as a result of the enormous size of the country, the essential differences in the general topography, the presence of large interior bodies of water, and the proximity to the Atlantic and Pacific Oceans. It is well to call attention briefly to the general characteristics peculiar to a few isolated localities.

The predominant features obtaining in the Adirondack Mountains

of New York are an altitude approximating 2000 feet, a comparatively small number of sunny days during the year, moderate humidity of the atmosphere, and an abundance of clouds, fog, snow, and rain. The winters are intensely cold, but the air at this season is much drier than during warm weather. The summers are cooler and more invigorating than many portions of New York State, but the heat is sometimes oppressive, even in this mountainous resort. The soil is sandy, and forests of pine abound. This region is known to possess many attractions for the pulmonary invalid in the novelty of surroundings, beautiful scenery, general diverting influences, opportunities for recreation, and very excellent accommodations. Here is situated the admirable Adirondack Cottage Sanatorium, the creation of Dr. E. L. Trudeau. The essential climatic attributes, however, do not vary materially in their general physiologic action from these obtaining in other health resorts scattered throughout the New England States, although local differences of minor importance are recognized. This locality has for many years enjoyed a well-deserved reputation as a place of sojourn for pulmonary invalids. The remarkable beauty of the lakes and forests and the excellent facilities for fishing, render the Adirondack region a pleasurable and appropriate resort for those whose physical infirmities do not preclude indulgence in outdoor sports. The highly satisfactory results so frequently attained in the Adirondacks from systematic medical supervision are worthy of especial mention. The same is true of the Loomis Sanatorium for Consumptives under the management of Dr. Herbert Maxon King, and situated at Liberty, Sullivan County, New York.

Asheville, N. C., is situated at an elevation approximately identical with that of the Adirondacks. The adjacent country is mountainous and heavily wooded. As a general rule, the temperature is comparatively equable, although extreme fluctuations sometimes take place. The relative humidity is high at all times of year. The winters are cold, although much less so than in the Adirondacks, while the summers are not oppressive. The snow, which remains for many weeks in the Adirondacks, melts speedily in Asheville, leaving the ground exceedingly muddy for considerable periods. This beautiful city, situated upon an elevated plateau with mountains but a few miles distant, rising an additional 1500 feet, offers advantages for a large class of pulmonary invalids. There are many fine residences, family hotels, and exceptionally well-appointed boarding-houses. The Winyah Sanatorium, under the direction of Dr. Karl von Ruck, has enjoyed a long and useful existence. The excellent accommodations outside of sanatoria render Asheville particularly inviting to those not desirous of residing within a closed institution. The mountain drives in almost all directions in the surrounding country are unusually attractive, while the scenery throughout the entire district helps to make this resort especially delightful both during the winter and the summer months.

Aiken, S. C., at an altitude of nearly 600 feet, is possessed of a sandy soil, moderate dryness of the atmosphere, and equability of temperature. There is but little wind and there are a considerable number of sunny days. The winters are warm and delightful, but the summers are exceedingly oppressive. The hotel accommodations are exceedingly good, while the Aiken Cottage Sanatorium provides excellent facilities for pulmonary invalids to pursue an open-air existence. This institu-

tion, under the supervision of Dr. C. F. McGahan, is one of the oldest sanatoria in the United States.

Those portions of Florida which in former years enjoyed a remarkable prestige as a place of sojourn for pulmonary invalids during the winter months, are characterized by warmth, moisture, equability, and high atmospheric pressure. In the interior of the State the atmosphere is not particularly moist and the sunshine fairly abundant, but the summers are quite enervating and wet.

The climate of southern California is of a somewhat tropical character, being depressing, sunny, moist, and, upon the whole, equable. Considerable differences obtain in various portions of this region, according to the proximity of the ocean, or a location in the drier mountainous sections. The climate at the seashore is essentially moist, and is quite undesirable for consumptives of any class. In Los Angeles but a very few hours of the twenty-four may be regarded as reasonably dry. Along the southern coast, both in summer and winter, the humidity is marked, and the fog noticeably dense in the earlier portion of the day. A foggy spell of seventeen days' duration is recorded at Santa Barbara in May and June of 1903. The humidity of the fogs penetrating inland from the coast is considerably greater than that of Boston or New York. Marked diurnal variations of humidity are found in resorts along the coast of the Pacific. While equability of temperature, sunshine, dryness of soil, with but little wind movement, are important climatic features, the vast amount of moisture in the air constitutes so important a characteristic as to result in frequent tendency to chilling, and to interfere seriously with a continuous out-of-door existence. A satisfactory conformity of the organism to the irregularity of demands for heat-production is sometimes quite out of the question. It is difficult to understand for precisely what class of pulmonary invalids, if any, the climate along the *southern coast* of California is really adapted. Upon the other hand, in the mountainous regions there are freedom from fog, diminished humidity, and absence of extreme heat or cold, resulting in less general depression and relaxation. In Dr. Pottenger's Sanatorium at Monrovia and in the Barlow Sanatorium near Los Angeles the general environment and character of accommodations are well suited to a class of pulmonary invalids.

The arid regions of Arizona possess climatic features of great value to the climatotherapeutist. While certain characteristics are common to the entire territory, a noticeable difference is observed in the altitude of various portions. Sandy deserts abound in a district far removed from large bodies of water. The country is broken more or less by numerous mountain-ranges with intervening valleys. The distinctive climatic attributes are *equability of temperature, extreme dryness, a maximum amount of sunshine,* with a considerable variation of atmospheric pressure according to location. An altitude of 1100 feet is found at Phœnix; of 2400 feet at Tucson, and of 5000 feet at Oracle, an attractive resort in the Galiuro Mountains, thirty-five miles from Tucson. It is stated that Phœnix has the *smallest percentage of humidity* and the *greatest amount of sunshine* of any city in the so-called arid region. The air is remarkably clear, and the days are, upon the whole, delightful. During the winter months the conditions are peculiarly conducive to the physical well-being of a large class of pulmonary invalids. At this season of the year a comfortable out-of-door existence is permitted

almost continuously, while the nights are cool and refreshing. A summer sojourn in this place is prohibited by the intense debilitating heat. Important drawbacks to many of the manifest advantages of Arizona are the comparatively short season during which the climatic conditions are particularly advantageous, the remoteness and inaccessibility, the occasional prevalence of high winds, the dust-storms, and the frequent difficulty in securing suitable accommodations in some resorts.

The features of climate prevailing in El Paso, Texas, and in southern New Mexico, in comparison with those enumerated as characteristic of Phœnix, are a diminished dryness, increased elevation, and lessened equability. There is, however, a large percentage of possible sunshine, but slight relative humidity, a dry, sandy soil, and cool nights. Owing to the large area included, with important differences of altitude and latitude in various regions, a considerable divergence of climatic conditions is found. The general features, however, are those of dryness, sunshine, diminished atmospheric pressure, and, in the elevated regions, a noticeable variability of temperature. A detracting influence from the general excellence of the climate relates to the occurrence of high winds, holding in suspension enormous clouds of dust, which are sometimes driven with extreme velocity. These winds are more prevalent during the winter and spring months, and exert an undeniable effect upon the nervous system of pulmonary invalids, who, for this reason, are prone to exhibit at times considerable irritability of temperament. The climate, especially in the northern portion and in the more elevated regions, is decidedly invigorating and conducive to increased metabolism. An outdoor life is permitted, as a rule, during the entire day. Save in the more elevated localities, the heat produces pronounced relaxation during the summer, often necessitating the removal of many phthisical patients to the cooler regions of Colorado.

While, for obvious reasons, it is not desired to exploit the virtues of any particular State, it must be admitted that in Colorado is found the nearest approach to climatic idealism for the great mass of pulmonary invalids. In common with northern New Mexico, the climate is extremely dry, with prolonged sunshine and intense solar radiation, marked diathermancy, low barometric pressure, variability of temperature, and moderate winds—in short, all the combined attributes which constitute a favorable climate for a large class of phthisical patients. Colorado, which is preëminently a land of sunshine and dryness, has been endowed by nature with a sandy, porous soil, an inspiring scenery, and all the invigorating qualities incident to moderately diminished atmospheric pressure. The climate cannot justly be regarded as equable, and in this, as previously stated, is concealed a desirable feature with respect to the regularity and degree of heat-abstraction.

Among the disadvantages sometimes stated to obtain from residence in this region are the extreme cold of winter and the high winds and dust, objections which, in point of fact, are more fancied than real. Despite numerous statements to the contrary by those unfamiliar with actual conditions, Colorado is indeed a delightful resort during the *entire* year, on account of the remarkable difference obtaining between the physical and sensible temperatures. Generally speaking, there is an absence of extremes of heat or cold, the winters not being characterized

by very low temperatures nor the summers by excessive heat. During the cold season the weather is rarely such as to interfere with a continuous out-of-door existence. At this time of year rain is exceedingly uncommon and snow-storms comparatively infrequent. The winter cold is seldom, if ever, depressing, save to extremely debilitated individuals. Upon the contrary, a general exhilarating effect is often noted, as a result of which appetite and digestion are stimulated to an appreciable extent. As opposed to the enervating sense of inertia peculiar to warm regions, the invigorating effect of a Colorado winter is, in fact, a positive advantage. It must be conceded that at times a distinct disadvantage relates to the prevalence of wind and dust. During a few of the spring months, and especially in the afternoon, there is more or less temporary annoyance from these sources, but it is seldom that the invalid is not permitted to remain in the open air upon a sheltering porch. These unfavorable factors obtain to a less degree than in Arizona and southern portions of New Mexico, while the relaxation from heat during the summer is comparatively slight. A desirable feature of considerable importance is the avoidance of necessity for removal from one climate to another at different seasons of the year. Such changes involve not only considerable expense, inconvenience, and difficulty of securing appropriate accommodations, but, above all, the frequent deviations from an appropriate régime. Instances of this are all too frequent within the experience of observers in health resorts in any locality. The climate of Colorado is in many respects similar to that of the Swiss Alps, though in the latter region there are fewer hours of possible sunshine and a severer winter, but a diminished amount of wind and dust.

Climatologic literature abounds with statistical comparisons of meterologic data, calling attention to essential differences of temperature, relative humidity, sunshine, precipitation, and wind movement in Colorado, and various *other localities* enjoying *well-deserved* reputations as health resorts. While portions of Arizona and New Mexico exhibit more dryness and in some instances increased equability of temperature, these qualities, though eminently desirable in themselves, are offset to some extent by the greater tendency to winds and dust, the lessened stimulating effect, the necessity of seasonal change, and not infrequently the existence of inferior accommodations. Comparisons between the meteorologic conditions obtaining in Colorado resorts and eastern localities are too invidious and familiar to justify enumeration.

It is just to assert that there is almost no part of Colorado where the invalid may not derive climatic opportunities for material improvement. In numerous communities throughout the State ample provision is made for the reception of visiting consumptives. Two localities suitable for residence during the entire year are worthy of special mention—Denver and Colorado Springs.

Slight mention need be made of the climatic attributes peculiar to Denver, which in general are similar to those already enumerated as obtaining in Colorado, but there are some essential features concerning which there has been more or less popular misconception. Attention has been directed from time to time to alleged disadvantages incident to the smoke from the smelters and other manufacturing establishments, the overcrowding of population, the excitement incident to the confusion and activity of a large city, the absence of outdoor diversion and recreation, and the difficulty of securing suitable accommodations.

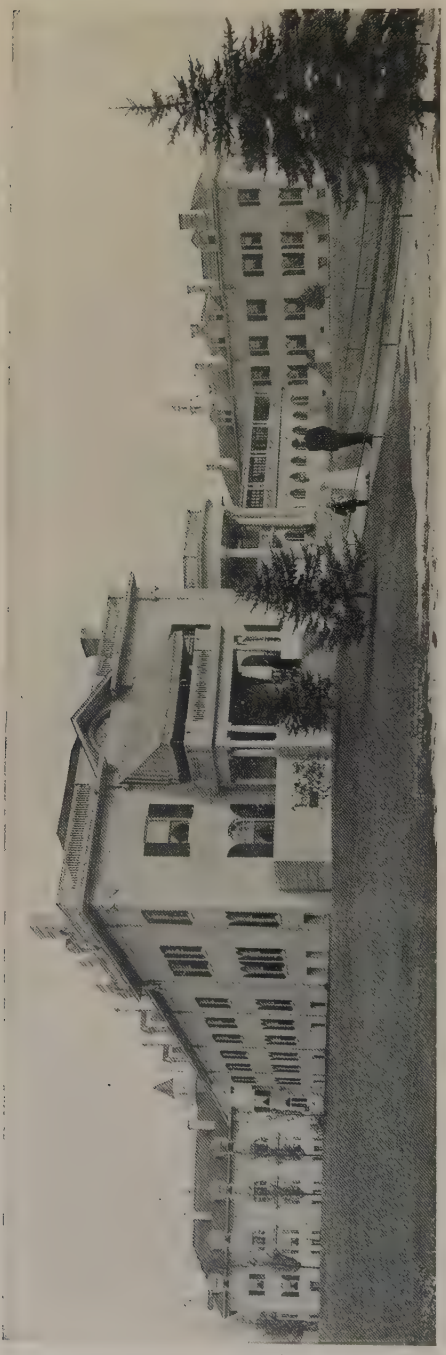


Fig. 159.—The Home, Denver, Colorado.

While a large amount of smoke is emitted from the chimneys of the smelting establishments upon the northeastern outskirts, this constitutes but a slight objection, as the prevailing winds carry the smoke away from the city to a great extent. Although a suitable environment is not offered to the consumptive in the thickly settled portion, it is impossible to find more ideal conditions than can be secured in the readily accessible outlying districts. Facilities for diversion and recreation are found in the various parks adjacent to the city, while for suitable cases the country clubs offer attractions for golf and social pleasures. The accommodations for pulmonary invalids are sufficiently ample, varied, and appropriate to suit the needs of the most fastidious. Provision is made, without especial difficulty, for those who prefer to board or domicile themselves in furnished houses.

An establishment, known as The Home, the creation of Rev. F. W. Oakes, has enjoyed a period of usefulness during the past twelve years. This institution, erected at a cost of $250,000, is located in the less densely populated portion of the city, and provides accommodations in its various departments for 150 patients. While the pervading spirit is not that of a sanatorium proper, it is doubtful if any institution, wherever located, can offer to a class of invalids more of the material comforts of life with greater opportunities for improvement than can be obtained in this place of abode. The Home is in effect an immaculately clean and attractive residence, designed for the exclusive accommodation of consumptives,

Fig. 160.—An upper porch at The Home.

Fig. 161.—A porch in connection with the hospital addition.

and has been found appropriate for a large class. By virtue of an unusual environment, patients are permitted to partake of its essential advantages and at the same time conform to such hygienic restrictions as may be imposed in individual instances. The establishment is open to any practising physician, and, therefore, without any fixed system of sanatorium régime. There is permitted to any medical attendant, however, the exercise of such supervisory control over his own cases as he sees fit to institute or has the power to maintain. By means of spacious, well-arranged porches, ample facilities are afforded for outdoor living. Scrupulous attention is devoted to the disinfection of apartments. The Home is pleasingly furnished, and provides very desirable accommodations for people with limited resources, as well as for those more

Fig. 162.—Another porch in connection with the hospital addition, Oakes Home.

favored financially. The expense varies in the several departments from $30 to $120 a month, according to individual requirements in the way of care and nursing. An idea of some of the pleasing features of this institution may be conveyed by the accompanying illustrations.

Excellent accommodations are also afforded at the Agnes Memorial Sanatorium, which is operated as a closed institution for the care of consumptives. This was founded through the generosity of Mr. Lawrence C. Phipps, of Denver, and is under the active management of Dr. G. Walter Holden.

A worthy institution, known as The National Jewish Hospital for Consumptives, bestows upon the very poor who are fortunate enough to gain admittance, a most substantial charity.

Colorado Springs, located at the base of Pike's Peak, presents climatic features closely resembling those obtaining in Denver. There is the

Fig. 163.—The cloister, Oakes Home.

same proximity to the great plains, the same abundance of sunshine, the large number of exceptionally clear days, the low humidity, and the

Fig. 164.—The Adams Memorial addition to the Home. Note porches connecting with each room.

small amount of rainfall. The altitude, however, is nearly 1000 feet higher, with a corresponding increase of variability. There are high

winds of somewhat increased prevalence and velocity, the latter being about one-third greater in Colorado Springs than in Denver. The disagreeable effect of the wind is intensified by fine particles of irritating dust, but these features, as a rule, do not represent a serious objection, save during the existence of dust-storms, which are comparatively infrequent. Patients rapidly accustom themselves to the increased air movement, which, if extreme, may be avoided by retiring to sheltered porches. By virtue of the location of the city at the juxtaposition of plain and mountain, there is a habitual diurnal variation in the direction of the local winds, precisely as takes place at the seashore. Solly has called attention to the customary daily variability of the wind as follows: "In ordinary weather, throughout the night, a gentle breeze blows from the north or northwest, and as the sun begins to rise the wind shifts eastward and, passing south, blows from the southwest during the early afternoon, then turning backward through the eastern quarter,

Fig. 165.—Home for nurses connected with the Oakes Home.

reaches the north once more as the sun goes down, where it lingers through the night. The velocity of the wind is very slight during the hours of darkness, but increases after daybreak up to two or three o'clock in the afternoon, when it blows with its maximum force, gradually dying down again as sunset approaches and it returns to the northern quarter. Thus there is by day a sea or plain breeze, by night a shore or mountain breeze." The population is composed largely of consumptives who have recovered their health by reason of sojourn in this locality. Contrary to the statements of some writers, the city exhibits a remarkably pleasing and imposing appearance, particularly in the residence district. The streets are unusually broad, and are rendered quite attractive by the abundance of shade trees. Exceedingly good accommodations may be obtained in numerous boarding-houses, as well as in the Glockner and Cragmor Sanatoria, both of which are admirably conducted. The former has been in existence for many years under the direction of the Sisters

of Charity and provides accommodations for about 200 patients. The latter was founded in 1904 through the efforts of the late Dr. S. E. Solly and the generosity of Gen. Wm. J. Palmer. It is located on the outskirts of the city, affords excellent accommodations for twenty-five patients, and is under the supervision of Drs. C. F. Gardiner, W. H. Swan, and H. W. Hoagland.

It is not to Denver and Colorado Springs alone that the invalid in search of health need look for suitability of climate, attractiveness of accommodations, and opportunity for recreation. According to seasonal changes, opportunity is afforded in other parts of the State for such temporary sojourn as may suit the inclinations and satisfy the apparent needs of those for whom a rational diversion is indicated to break an otherwise unceasing monotony. With the advent of warm weather patients may avail themselves of the facilities presented in various resorts for the enjoyment of country life and mountain air. Excellent accommodations may be obtained at Estes Park, seventy-five miles from Denver, at an altitude of about 7000 feet. This park, at the foot of Long's Peak, consists of a plateau about ten miles long and six miles wide, containing innumerable hills and valleys, and surrounded by gigantic mountains with snow-clad peaks and craggy precipices. Fifteen years ago the late Dr. Ruedi, upon arrival from Switzerland, endeavored to select in Colorado a location suitable for comparison with Davos as to climatic characteristics, fauna, and flora. He found that "a difference

Fig. 166.—Portion of Estes Park.

of 2000 feet between Colorado and Switzerland was required to put invalids under the same conditions." Considerable resemblance was shown between Estes Park and Davos, except as to the factor of altitude.

Fig. 167.—Another view of Estes Park.

As a result of close meteorologic observation he was enabled to call attention to a diminished variation in the barometric pressure in Estes Park as compared with that of Davos, and to the far greater number of

Fig. 168.—Summer residence at Estes Park.

hours of possible sunshine. A striking difference in the humidity was also noted, the absolute precipitation in the Swiss mountains being considerably in excess, but the prevalence of wind decidedly less marked.

Attention is sometimes called to the supposed inability of invalids to return home after an arrest has been secured in high altitudes. It is hard to conceive how residence at high elevations can render the invalid more susceptible to a renewed activity of the tuberculous process upon return to the lowlands. Even were this true, however, it would not militate against prompt recourse to the favorable influence of moderate altitudes. In no event could this consideration be construed as an argument against sending patients to elevated regions, but merely against permitting them to return until a definite arrest has been established. Furthermore, the vital desideratum in any case is an early restoration to health, rather than a regard for the patient's welfare after recovery has been secured.

CHAPTER XCVI

TREATMENT OF SPECIAL SYMPTOMS

THE treatment of the various complications has been described in connection with their clinical manifestations. The general management of fever has been discussed at length in the chapter devoted to Mixed Infection. Among the other symptoms the treatment of which is worthy of special mention, cough, digestive disorders, night-sweats, nervous disturbances, cardiac weakness, and insomnia are of importance. The treatment of pulmonary hemorrhage will be considered in a separate chapter.

COUGH

No single symptom is comparable with cough in its constancy, varying character, and differing indications for therapeutic management. While cough is almost always present to some extent, there is often displayed a remarkable difference in the frequency, general character, and degree of severity. It has been shown that there is no definite relation between the intensity of cough and the extent or activity of the tuberculous infection. This symptom is sometimes of *minor* significance, even in *advanced* phthisis, and not infrequently an *important* disturbing factor in *early* cases.

In view of the personal element, so largely operative in the production and nature of cough, it follows that rational palliative management should take cognizance of individual idiosyncrasies. The cough is loose, and attended by useful expectoration in some instances, while dry, paroxysmal, exhausting, and unnecessary in others. In recognition of the divergence of therapeutic indications it follows that efforts to limit its frequency and mitigate its severity are not appropriate for all cases. Routine methods of allaying cough should be rigidly avoided, the nature of the treatment in individual cases depending largely upon the causal conditions and the associated disturbances. In general, it is desirable to reduce to a minimum the oversensibility of the bronchial tract. Among some invalids promotion of expectoration is demanded, but in a large proportion of cases the amount of bronchial irritability is far in excess of that required to free the respiratory passages.

Preliminary to the institution of treatment, it is of prime importance to conduct a critical inquiry as to the existence of local causative factors. The pharynx should be carefully inspected in order that a prolonged uvula may be amputated if necessary, and enlarged follicles upon the posterior wall of the pharynx destroyed. The larynx also should be examined, that areas of infiltration, ulceration, or necrosis may be subjected promptly to local treatment. The recognition of cardiac embarrassment is of importance, for a venous engorgement of the pulmonary circulation often predisposes to the development of bronchial irritability. In this event the exhibition of nitroglycerin and other remedies to relieve the pulmonary congestion is frequently attended by signal benefit. The coëxistence of nephritic disturbance, a rheumatic diathesis, gout, and chronic alcoholism should be ascertained, and treatment appropriate for the underlying condition immediately inaugurated. Exposure to dust, wind, or smoke should be restricted, and loud or prolonged talking enjoined.

The medical advice should be governed largely by the character of cough, the conventional administration of syrups and sedative tablets, irrespective of other considerations, being productive of no inconsiderable harm.

It is highly inexpedient to resort to the employment of any agent not absolutely demanded, and, above all, to permit its use according to the fanciful judgment of the patient.

As a rule, ample measures are available for the restriction of cough without recourse to opiates. In all cases of dry cough with unnecessary and spasmodic efforts toward the expulsion of expectoration, detailed utilization of various hygienic measures are of great value. These paroxysms have been described as occurring after heavy meals, upon change of position, as arising in the morning or retiring for the night, upon abrupt alternation of heat or cold, upon exposure to raw, chilling winds, inhalation of smoke or dust, indulgence in physical exercise or inordinate laughter, and during a state of mental excitability. The frequency and severity of spasmodic cough are also aggravated to no little extent by disturbances of digestion and constipation. It is at once apparent that the obligation of the medical attendant relates not to the unthinking administration of sedatives, but to the comprehensive recognition of all influences responsible for the cough, whether general or local, and attention to their removal or control. The degree to which excessive bronchial irritability with exhausting cough may be relieved by carefully supervised hygienic measures is almost beyond belief. Successful results are greatly facilitated by the willing coöperation of the patient, which can be secured only by a detailed recital of the possible causative influences.

In many cases complete physical rest in the recumbent or semi-reclining posture should be secured for at least one-half hour after meals. This, of course, is particularly suited *only* to patients whose paroxysms of cough are not excited upon assuming this position. It is especially appropriate for those with decidedly nervous temperament, and with marked susceptibility to variations of external temperature. It is important that meals should not be eaten at times of mental excitement or physical exhaustion, as the tendency to cough and vomit is then accentuated to a marked degree. Inasmuch as the coughing at such a time is largely of reflex origin, it is often desirable to restrict the amount of food

ingested with the meals. Many patients are able to receive into their stomachs a moderate quantity of food without excitation of paroxysmal cough, but exhibit, upon overindulgence, distressing reflex irritability. Invalids of this class should receive their food *frequently*, but in comparatively *small amounts*. Bits of ice may be held in the mouth after eating if the tendency to cough is pronounced. In extreme cases tablets containing a small amount of cocain may be slowly dissolved in the mouth, or the fauces may be sprayed with a weak solution.

The influence of change in position is illustrated by the customary cough in the early morning and late evening. At such hours the need of controlling cough is less apparent than at other times, as the expulsion of the secretions is more or less imperative and the danger of reflex vomiting much diminished. During the balance of the day, particularly after taking food, the restriction of severe cough *sometimes necessitates* rest in the upright position, or at most reclining slightly in an invalid chair. Many patients complain bitterly of the cough which ensues immediately upon lying down at night, resulting in the loss of the evening meal from reflex vomiting. This unfortunate occurrence is far more apt to take place when invalids retire shortly after food is ingested. While it is highly desirable to secure as many hours of sleep as possible, this in no case should take precedence over efforts to control the paroxysmal evening cough. In such cases it is my custom to instruct patients to partake somewhat sparingly of the evening meal, and to retire for the night *not until after* the lapse of several hours. Animated conversation, music, and playing and other forms of social indulgence are interdicted. Exposure to the cold night air is often injudicious for this class of invalids, even if at rest upon the porch. Quiet and seclusion in a well-ventilated and not overheated room are indicated until such time as the processes of digestion are well established. The evening may be spent in light reading, with the patient in a semiupright posture. Experience has shown that in many instances the later hour of retiring is compensated for by the diminished tendency to cough when the recumbent position is finally assumed, by the lesser likelihood of reflex vomiting, and by the greater probability of securing unbroken sleep.

In all cases the frequent alternation of hot and cold air must be avoided as far as possible, and protection afforded from drafts, chilling winds, or atmospheric contamination with smoke or dust. Physical exercise and undue hilarity incident to exuberance of spirits must be prohibited until cough has been subdued within reasonable bounds.

The ingestion of copious drafts of hot water upon arising in the morning, with or without the addition of sodium phosphate or other alkaline preparation, is often peculiarly efficacious in relieving the severity and shortening the period of morning paroxysms.

Subjective control on the part of the patient is of exceeding importance. Invalids should be taught to repress the desire for coughing unless assured that the expectoration is easy of expulsion. To a very great extent the frequency of cough is influenced by habit, which, by the exercise of firm volition, is capable of much restraint. It is particularly desirable, for obvious reasons, that the tendency to cough should be overcome at meal-time, and the possibilities for repression at this time are sometimes remarkable.

Counterirritation over the sternum is frequently of some value in lessening the severity of cough during acute bronchial exacerbations.

At this particular period inhalations are also of considerable benefit, but should not be employed for over a few days at a time. In acute cases the inhalation may consist of various combinations of eucalyptus, menthol, thymol, oil of pine, and phenol, and in chronic cases of creasote, balsam of Peru, tincture of benzoin, iodin, terebene, etc. During periods of excessive irritability considerable improvement is sometimes afforded by this means. It is essential that the inhalation of medicated steam be practised in great moderation, and that the patient refrain from going out-of-doors until at least one-half hour has elapsed. The spasmodic cough, characterized by absence or tenacity of expectoration, is favorably influenced in many cases by the periodic administration of the syrup of hydriodic acid. An experience of many years with this agent has established the conclusion that, administered three times a day for varying periods, it is often capable of lessening the severity of cough to a material extent and promoting ease of expectoration.

In case the cough remains persistent in spite of hygienic measures, deleterious effects are inevitably observed in the production of reflex emesis, impairment of nutrition, disturbance of sleep, and diminution of strength. Under these circumstances relief should be afforded within moderate limits by the judicious employment of sedative agents, among which codein and heroin take the first place. In many cases codein may be combined to advantage with terpin hydrate in doses of $\frac{1}{4}$ and $2\frac{1}{2}$ grains respectively. Drug therapy for the relief of cough should be restricted as much as possible, and under no circumstances should be left to the judgment of the patient. Opium derivatives may be administered either in tablet or liquid form, but if the latter is used, care should be taken to exclude syrups, on account of their pernicious influence upon digestion. Not until all hope of recovery has vanished, should the comfort of the patient with distressing cough, be promoted by the free exhibition of morphin, heroin, or codein.

DIGESTIVE DISORDERS

The contraindications for excessive feeding, together with the general principles of dietetic treatment, have been described in connection with the general subject of superalimentation.

The dietetic and *medicinal* management of the various disturbances of the gastro-intestinal tract is attended by the assumption of much responsibility, for on the preservation of digestion rests the chief hope of the consumptive. In addition to the possibility of *organic* change in the alimentary canal, exceptional opportunities are afforded for the development of *functional* disorder. Attention has been called to the apparent incapacity of the digestive apparatus by reason of unfortunate neurotic disturbances, sometimes incident to the course of pulmonary tuberculosis. Allusion has been made to the effect of fever and toxemia upon the gastric secretions, and to the pernicious influence of indiscriminate stuffing, combined with restriction of physical exercise. If to these factors, which are profoundly instrumental in impairing digestion, there is added the evil of injudicious medication, it is no wonder that consumptives become sadly handicapped in their struggle for recovery.

Acute disturbance of gastric digestion, which not infrequently results from indiscretions of diet, suggests the wisdom of immediate food restric-

tion, and the administration of calomel in small doses until from one to two grains have been taken. This should be followed by a mild saline laxative upon the ensuing morning. The calomel is especially indicated if the tongue is furred and the breath heavy. After thorough movements of the bowels and practical starvation for twenty-four hours, increasing amounts of food should be permitted, but starches, sweets, and fats should be temporarily avoided. The essential therapeutic indications are as stated, the free evacuation of the bowels from the exhibition of calomel, rest for the gastro-intestinal tract, liquid nourishment for one or two days, a gradual resumption of solid food, and the administration of bitter tonics, which in many cases should be combined with hydrochloric acid. As stated elsewhere, the hydrochloric acid is often deficient among pulmonary invalids, suggesting in many instances the expediency of employing this remedy. It is inexpedient to resume at once efforts toward superalimentation, raw eggs and milk between meals being ingested but sparingly. Disturbances of this nature, though prone to recur from time to time, yield quickly to simple treatment.

Chronic gastric indigestion, characterized by confirmed anorexia, distress and pain after eating, pyrosis, nausea and vomiting, and even localized tenderness, is far more obstinate in its response to therapeutic management. This grouping of symptoms, as previously stated, may be dependent upon structural abnormality of the stomach or upon functional disturbances incident to profound psychoneurosis. The organic condition may be that of chronic catarrh with atrophy of the mucosa, muscular atony, and dilatation, with not infrequently enteroptosis and associated change in other abdominal organs. It is sometimes with the utmost difficulty that the causative conditions may be differentiated, although in general the means for distinguishing between the purely organic and functional disorders are sufficiently clear to admit of intelligent therapeusis.

The *structural* changes may be accompanied by cardialgia, which is often acute. There may be redness of the tip and margin of the tongue. Eructation of gas is an annoying symptom, which is sometimes intensified by the regurgitation of bitter or sour fluids. Hydrochloric acid is usually diminished to a considerable degree, though other acids are often present. The treatment of the purely catarrhal type should consist primarily of the temporary enforcement of a rigid milk diet. The milk may be diluted, if necessary, with Apollinaris, Vichy, or other effervescent waters. It is sometimes important that it be peptonized until the patient is able to bear solid food. At this time it is essential that mastication should be thorough, and the patient compelled to devote an unusually long time to the ingestion of food. Potatoes and other starchy vegetables should be forbidden, together with fats, sweets, pastry, and hot bread. Certain fruits are often injurious for some people, restriction in this respect being a matter of individual application. In cases exhibiting hypochlorhydria, dilute hydrochloric acid should be given freely, together with pepsin and other digestive ferments. Bismuth preparations with sodium bicarbonate may be administered, while strychnin or nux vomica are of some value in promoting the appetite. In obstinate cases daily irrigation of the stomach in the early morning with a 3 per cent. solution of sodium bicarbonate or of boric acid is of decided advantage. Some patients are able to practise autolavage with signal benefit, without the use of the stomach-tube. Those who

can easily bring about emesis should be instructed to drink a quart of hot normal salt solution or boric-acid solution about an hour before breakfast. If regurgitated without difficulty, this method is highly efficacious. Good results are often obtained by repeating the lavage late in the evening. Washing of the stomach is particularly indicated in cases of mucous gastritis, dilatation of the stomach, and atony of its walls. When this condition exists, fluids should be somewhat restricted, the solid food given in small quantities and at frequent intervals, scraped beef and tender meats being especially well borne. In the event of pronounced enteroptosis, support for the abdominal organs should be provided by a belt or by the application of adhesive straps.

The *functional* neuroses may also be attended by violent eructation of gas, vomiting, partial regurgitation of food, and gastric distress or distention after eating. The appetite is not invariably poor, nor is aversion to food continuous, fickleness of appetite often being a striking characteristic. An important feature is the accentuation of pain and belching when the stomach is empty, rather than immediately after the ingestion of food. The symptoms referable to the dyspepsia sometimes completely overshadow the manifestations of tuberculous infection. As the clinical symptoms are often extremely complex, representing a great variety of neurotic disturbances, it is obviously irrational to attempt to treat patients of this class along purely symptomatic lines. Gastric analyses are of importance largely by reason of their moral effect. The same is true of a strictly regulated dietary, which, for psychic reasons, should not be enforced for prolonged periods.

The underlying principles of treatment should be those of suggestion, rest, fairly generous alimentation, and detailed supervision of the mode of life. Upon the intelligent application of these features will depend ultimate success, far more than upon the perfunctory selection of diet with reference to alluring symptomatic indications, a study of the stools or of the stomach-contents.

Considerable difficulty is usually experienced in overcoming the prejudices and preconceived notions of patients, who protest their utter inability to digest certain articles of food. It is sometimes advisable to begin with small quantities of such easily digested foods as milk, broths, eggs, oysters, squab, chicken, and tender meats. Starches should be given but sparingly, but fats may be administered in fairly moderate amounts. Among chronic dyspeptics encouragement and reassurance should be freely extended, for much depends upon the establishment of renewed hope, and an increasing confidence in their digestive powers. Food should be given between meals, in order that the stomach may at no time become perfectly empty.

The clinical judgment may be taxed in deciding between the relative advantages to be derived in individual cases, from exercise or complete rest. In general a preliminary recourse to a modified rest treatment, with isolation and competent nursing, is peculiarly efficacious, but in some cases the indications point to diversion, recreation, and carefully adjusted physical exercise. It is absolutely essential that this, if permitted at all, should be unattended by fatigue, lest the functional disturbances become aggravated to a considerable extent. It will be seen that the treatment of this form of chronic dyspepsia, so common among neurotic consumptives, is based upon the *treatment of the individual*, rather than of the stomach. In addition to change of scene,

environment, method of living, and judicious modification of diet, it is often important to administer certain medicines as aids to digestion, as well as for their general effect. Nux vomica and strychnin are of considerable value, as are alkaline remedies in large doses in the form of magnesia or sodium bicarbonate. Preparations of bismuth may be indicated, as in catarrhal conditions of the stomach or intestine. The various bitter tonics are of some efficacy in a few cases. For severe pain anodyne remedies are sometimes appropriate, but should not be administered save in exceptional instances. In some cases nausea is controlled by small doses of ingluvin. If the general nervous disturbance is pronounced, excellent results may be obtained from the administration of the aqueous extract of opium, in association with cannabis indica. The combination which I have used for years in innumerable instances with exceedingly satisfactory results is strychnin, $\frac{1}{30}$ grain, salol, 5 grains, aqueous extract of opium, $\frac{1}{10}$ grain, extract of cannabis indica, $\frac{1}{15}$ grain, aloin, $\frac{1}{40}$ grain, after each meal. In no case has there been observed any untoward effect of the opiate, or a tendency toward habituation. Upon the contrary, with the control of general nervous manifestations, digestion, as a rule, is improved, mental excitability diminished, and insomnia relieved. In view of the preponderance of nervous symptoms in a large proportion of cases, and the difficulty of successful management on account of these neurotic disturbances, it is my firm conviction that the employment of the above-mentioned combination in capsule for such patients is of inestimable value.

Constipation, which is often present at any stage of pulmonary tuberculosis, may be favorably influenced by colon massage. As this symptom is exhibited more frequently in incipient cases, judicious exercise is permissible for a large number of patients, combined with the ingestion of raw fruits and coarse vegetables. Regularity of bowel evacuation should be insisted upon with the utmost strictness. Copious quantities of hot water should be taken an hour before breakfast, which, if insufficient, may be reinforced by the addition of sodium phosphate or other alkalis. For occasional use small quantities of Hunyadi water often suffice if taken immediately upon arising. Sweet-oil enemata are sometimes of advantage, together with preparations of cascara by mouth.

The treatment of *diarrhea*, which may be of catarrhal, tuberculous, or amyloid origin, is especially important. Recent clinical investigation has shown that tubercle bacilli are present in the feces more often than has been supposed. Rosenberger has found bacilli in the fecal discharge of a number of individuals who were not suspected to be subjects of tuberculous infection. In a large proportion of these cases the autopsy findings disclosed tubercle deposit in some portion of the body.

The nature of the treatment is not necessarily dependent upon a determination of the fundamental character of the diarrhea, all three varieties demanding practically the observation of the same general measures. The diet should be restricted almost entirely to milk, soup, and albuminous foods. Lean meats, eggs, fish, and oysters may be given freely, but no vegetables, fruits, or pastry should be allowed. It is sometimes necessary to insist upon protracted confinement in bed and an exclusive diet of boiled milk. It is excellent practice to empty the bowels at intervals with calomel in divided amounts, or with sweeping doses of castor oil, following which there is not uncommonly secured a temporary respite from the annoying diarrhea. Among the intestinal astringents

of considerable value may be mentioned the salicylate and subgallate of bismuth, tannigen, and tannalbin. Sixty to eighty grains of salicylate of bismuth should be given daily, while the subgallate may be administered in still larger amounts. Thirty to forty grains of tannigen may be given each day, supplementary to either the salicylate or subgallate of bismuth. In very obstinate cases recourse may be taken to powdered opium and subacetate of lead, in doses of $\frac{1}{4}$ grain and one grain respectively. Enemata of starch, with deodorized tincture of opium, may be occasionally employed, together with solutions of silver nitrate. In the event of intestinal flatulence resulting from excessive fermentation, antiseptics are of more importance than astringents. A most excellent remedy for this purpose is the beta-naphthol bismuth, given in seven-grain capsules two hours after eating. Creasote is often of undoubted efficacy in small doses, its effect being somewhat enhanced by the addition of $\frac{1}{8}$ grain of menthol.

Mucous colitis is not especially infrequent among pulmonary invalids, particularly of the neurotic type. Paroxysmal attacks of pain and tenderness in the abdomen, with the passage of mucous shreds or strings, may be associated with periods of excessive mental worry or excitement. The treatment should be directed essentially toward the management of the general condition, with dietary precautions, although high irrigation of the colon with normal salt solution is sometimes attended by satisfactory results. Only such food should be permitted as is easy of digestion. Meats may be given freely, but green vegetables, fats, and starches should be interdicted. The treatment of intestinal tuberculosis has been described under Complications.

Instances of acute intestinal toxemia also are not infrequent among phthisical patients. The attacks are invariably of sudden onset, characterized by chill, headache, and often severe pain in the back and limbs. With the history of constipation the tongue is often heavily coated, the breath offensive, and the taste of the mouth extremely unpleasant. Without other symptoms directly referable to the gastro-intestinal tract, the temperature may range as high as 103° F., but sometimes does not exceed 101° F. The patient, as a rule, is completely prostrated, and the general clinical manifestations are those of a severe mixed infection of some kind. There may be tenderness in the abdomen, but this is not present in all cases. Occasionally small hard papules appear on the hands, arms, or body, and itch intensely, suggesting the gastro-intestinal tract as the seat of the trouble. The condition is differentiated from influenza by the absence of cough or catarrhal symptoms in the upper air-passages. Tonsillitis is excluded by inspection of the throat, and pneumonia in most instances by physical examination of the chest. The possibility of tuberculous meningitis may be eliminated only after careful observation of the case. The initial therapeutic indications consist of immediate purgation with large doses of calomel, followed by magnesium sulphate. After the bowels have been thoroughly evacuated, high enemata of normal salt solution should be freely administered and water given in large amounts by the mouth, with diuretin or potassium citrate to stimulate the kidneys. Food, of course, should be restricted during the acute stage, the chief efforts at treatment being directed toward evacuation of the bowels, gastro-intestinal rest, dilution and elimination of the toxins.

NIGHT-SWEATS

Attention has been called to the intimate relation between night-sweats and fever, both symptoms being characteristic manifestations of mixed infection. In such cases the perspiration accompanies the fall of temperature in the early morning hours. Night-sweats, however, may be observed *without* appreciable temperature elevation, and, *per contra*, may *not* accompany the fever of sepsis. Despite the inconstancy of association with fever and other subjective symptoms referable to mixed infection, it is probable that in all instances night-sweats are influenced to some extent by the effect of toxemia upon the vasomotor system. When sweating occurs as an incident of elevated temperatures, it is rational, if not obligatory, to concentrate therapeutic efforts for the time being, upon the reduction of fever in the manner elsewhere described. It is not always true, however, that disappearance of the night-sweats will follow a subsidence of the fever. Thus measures are indicated for the relief of the night-sweats, whether or not fever is present. For this purpose hygienic measures are of especial importance. Generally speaking, the tendency to night-sweats will diminish with the more complete elaboration of a system of outdoor life. In addition to the constant supply of fresh air and perfect rest in the recumbent position, it will be found that dietetic and hydropathic methods often suffice to cause the disappearance of night-sweats without recourse to drug therapy. The bed-covering should be light and of woolen material, to the entire exclusion of comforters, quilts, or heavy spreads. Generous alimentation with regulation of the digestion is fundamentally important. If the temperature is not materially elevated in the latter part of the day, the patient should partake of a hearty evening meal, which may be followed by light nourishment at bedtime. Two or three teaspoonfuls of brandy upon retiring may be administered with advantage. The body should be sponged with dilute alcohol or some acidulated preparation, in the latter part of the afternoon, and again in the late evening. Vinegar or dilute acetic acid may be used for this purpose. Quinin dissolved in alcohol is sometimes employed in the proportion of one dram to the pint. In my own experience excellent results have attended the use of chloral hydrate dissolved in brandy and water, 2 drams being added to 4 ounces each of brandy and water. Sponging the surface of the body twice daily with these solutions, which are allowed to evaporate upon the skin, often mitigates the severity of the night-sweats, if not affording complete relief. In obstinate cases medicinal measures are indicated from time to time. Camphoric acid has frequently been successful in doses of 15 grains two or three times a day, preferably after the midday and evening meals. In my experience this method of administration has been preferable to the employment of a large dose at bedtime. Picrotoxin, in doses of $\frac{1}{100}$ to $\frac{1}{50}$ of a grain, and agaricin, $\frac{1}{20}$ to $\frac{1}{12}$ of a grain, are recommended. The latter should be given not less than six or eight hours before the time of the expected sweat. If all other measures are found of no avail, atropin, in doses of $\frac{1}{100}$ to $\frac{1}{60}$ of a grain, may be given at bedtime, though recourse to this drug should be deferred as long as possible on account of its disturbing action upon the digestive functions.

INSOMNIA

Sleeplessness may result from cough, physical discomfort, digestive disturbances, night-sweats, unpleasant dreams, general restlessness, and nervous excitability. Any comprehensive system of management must be based upon an accurate recognition of the predisposing causes, attention to cough, night-sweats, and digestive disorders being suggested as essential prerequisites for undisturbed sleep.

The bed should be comfortable, the clothing neither too light nor too heavy, and the general environment suited to the needs of the patient. It is unwise to permit indulgence in a hearty meal shortly before retiring for the night. Mental perturbation also should be scrupulously avoided, particularly in the latter part of the day. Mental suggestion, if practised intelligently and persistently, may accomplish much in the control of insomnia. Hot drinks at bedtime, particularly milk or malted milk, may increase the tendency to sleep, while a small bottle of ale is of some service provided the digestion will permit. A hot mustard foot-bath in the latter part of the evening is often advantageous, as is cold sponging of the entire body. I have frequently found massage at bedtime to be of signal benefit in promoting sleep which, under other circumstances, seemed almost impossible of attainment. Hypnotics should be given only in extreme cases, and then but for brief periods of time. In such cases it has been my practice to administer an initial dose of from 10 to 15 grains of trional or veronal in hot milk, and, if possible, induce profound sleep for a single night. Upon the following evening not over half the dose is administered, and even less upon the third. Upon the several ensuing nights the milk is administered alone, without the knowledge of the patient. When occasion requires, small doses of the hypnotic are renewed from time to time, the object being to secure the greatest amount of sleep with a minimum use of the drug. Opiates should not be employed for this purpose under any circumstances.

CARDIAC WEAKNESS

It has been emphasized, in preceding pages, that rest, subject to modification according to the requirements of the individual, is an essential feature of modern therapeutic management. *Absolute* rest in bed is demanded for patients exhibiting manifestations of cardiac weakness. It goes without saying that tachycardia, palpitation, breathlessness, exhaustion, edema of the extremities, and dizziness of cardiac origin, permit of no deviation from this procedure. By rest is not meant simple physical inertia, but also a complete avoidance of mental excitement. Worry, agitation, and the strain of maintaining a wearisome conversation are as much to be prohibited, as indulgence in bodily exercise. The various symptoms of heart weakness are frequently traced to the existence of pronounced neurasthenic conditions, which in themselves are influenced for good by enforced repose. The cardiac manifestations *often improve commensurately* with gain in the general strength, and in the more stable equilibrium of the nervous system. Digitalis and strophanthus have been found to be of little value. In most cases strychnin is the remedy *par excellence*, and in appropriate conditions may be associated with nitroglycerin. Camphor has been

used to some extent with quite successful results. Ten to twenty minims of a sterilized 10 per cent. solution in olive oil may be administered for several weeks without especial inconvenience to the patient, and often with evidence of signal improvement. Aromatic spirits of ammonia, and alcohol, in the form of whisky, brandy, or champagne, are especially desirable if the heart weakness is accompanied by fall of temperature. The application of an ice-bag is sometimes of service, particularly in cases of pronounced tachycardia. Light massage with carefully adjusted resistance exercises are occasionally permissible, provided, of course, the nature of the cardiac difficulty is suited to the application of these measures. Obviously, the latter form of therapeusis for the heart, though eminently satisfactory to the requirements of certain individuals exhibiting a coincident slight tuberculous infection, is entirely inappropriate for advanced cases.

CHAPTER XCVII

TREATMENT OF PULMONARY HEMORRHAGE

GENERAL CONSIDERATIONS

The treatment of this condition is uniquely different from that of hemorrhage occurring in other parts of the body, by virtue of the fact that management is restricted to palliative and expectant measures, to the entire exclusion of surgical procedures. In sharp contrast to the prompt exposure and ligation of bleeding points within the abdomen, loss of blood from ruptured vessels in the *thorax* must be controlled, if at all, through supplementary aid to the natural agencies productive of spontaneous arrest. Fortunately, the undisturbed forces of nature are much more likely to effect a cessation of hemorrhage from the lungs, than from abdominal organs, the contraction of vessels and thrombus formation often taking place before exsanguination is complete or collapse profound. The inherent tendency of the organism to effect a spontaneous control through *reduction of volume, increased coagulability,* and *diminished rapidity of blood-flow* undoubtedly explains the surprising number of recoveries in the presence of divergent and sometimes irrational methods of practice.

The management of no other clinical manifestation calls for an equal display of judgment and acumen on the part of the physician, and demands such implicit obedience from the patient and attendants. The conception of treatment should be preëminently practical, rather than theoretic, and, in fact, may become almost intuitive. No attempt should be made to base the nature of therapeutic management in different cases upon a precise determination of the possible causes. Such differentiation is quite impracticable, and bears no actual relation to the manner of treatment. Not only is it of but slight importance to *distinguish between the various anatomic conditions* responsible for the production of hemorrhage, but in like manner the *recognition* of the *extent and character of gross pathologic change* fails to modify appre-

ciably the indications for rational therapeusis. It is frequently impossible to secure perfect familiarity with the physical condition, on account of the inexpediency of conducting a thorough examination until the likelihood of recurrence has subsided. While the information concerning the existence of pulmonary cavities, areas of consolidation, or of fibroid induration does not materially influence the character of therapeutic management, certain features of pathologic import are possessed of great significance, notably the presence of mixed infection, chronic nephritis, and the development of septic pneumonia. The vital consideration is the modification of treatment according to an intelligent interpretation of the *clinical manifestations*, rather than from a groping assumption as to the *exact causative influences*. Clinical features of great moment in association with hemorrhage, are elevation of temperature, cyanosis, heightened blood-pressure, the acceleration or feebleness of the pulse, dyspnea, and collapse.

It is of the utmost importance to appreciate the *varying* indications for treatment which are presented by different people, and often from hour to hour by the same patient. In every case of pulmonary hemorrhage the management should be determined to a large extent, according to the peculiar clinical manifestations exhibited by the individual. Under no other circumstances are the exercise of vigilant observation, attention to detail, and a critical study of cause and effect more necessary. No medical practice can be productive of *more harmful results* than the *employment of routine methods* in the treatment of hemoptysis, to the exclusion of a wise discrimination regarding drug therapy and hygienic details. Numerous remedies without regard to their physiologic action, or their suitability for special cases are occasionally administered in a spirit of utter empiricism. In other instances, purely theoretic notions are elaborated as to the effect of certain drugs upon the general and pulmonary circulation, while erroneous conceptions are not infrequently entertained regarding the influence of external hygienic measures. Thus a disproportionate value may be attached to a few time-honored remedies, with neglect to utilize important features of régime. The administration of medicinal preparations, with a few notable exceptions, is attended by directly harmful results, while detailed supervision of the patient and surroundings is remarkably efficacious. In disparaging the employment of general drug therapy for pulmonary hemorrhages, it is important not to include one or two remedies which exert a profound influence upon the entire system, with indirect effects upon the pulmonary circulation. As will be seen presently, their value in judiciously proportioned doses is exceedingly great.

THERAPEUTIC MANAGEMENT

The treatment of pulmonary hemorrhage has been thought to be capable of division into palliative and preventive efforts. It appears quite unnecessary, however, to make this distinction *save in extreme cases*, as there is no essential difference characterizing the attempt to arrest bleeding, and the endeavor to prevent immediate recurrence. Hemorrhages often take place in serial form, one following another either in comparatively quick succession or after the lapse of a few hours. Occasionally one or two days may intervene between these distressing experiences. In view of the tendency to prompt recurrence and the neces-

sity of continuous rigid precautions, the palliative treatment naturally resolves itself into one of prevention. The physician is rarely present at the time of the initial hemorrhage, while the subsequent recurrences form but an incident in the general scheme of systematic management. In view of the many degrees of severity, the manifold phases exhibited, and the variety of therapeutic indications in different instances, it is manifestly impossible to recite in detail methods of treatment properly applicable to hypothetic cases. Broad generalizing statements, however, may be made from which to formulate principles capable of individual application.

Important features of treatment relate—(1) To the initial directing influence of the physician; (2) attention to vitally important details of management and environment; (3) rational employment of selected drugs; (4) application of special methods.

INFLUENCE OF THE PHYSICIAN

Experience has shown that in the very beginning of treatment a firm, controlling influence upon the mental attitude of the patient is of incalculable value. Nothing is more subservient of good results than the possession of a calm, hopeful frame of mind, combined with an earnest desire for obedient coöperation. Such mental status is often exceedingly difficult of inculcation, and is dependent to an enormous extent, upon the personal influence and demeanor of the medical attendant.

Extraordinary differences are exhibited by patients in the mental effect established by the incidence of pulmonary hemorrhage. Many are prone to regard the occurrence as of trifling significance, and affect a seeming indifference. With apparent nonchalance they boast of the number of hemorrhages experienced, and, strangely enough, manifest pride in their previous non-conformity to instructions. To such patients, who are referring continually to their past record, it is with the utmost difficulty that there may be conveyed an adequate appreciation of the importance of the condition, and the necessity of careful supervision. Not infrequently these people, doubting either the sincerity or the soundness of their medical advice, are loath to accept the statement, that recovery from an astonishingly large number of hemorrhages affords no valid excuse for ignoring the possible gravity of recurrences. It is not uncommon in health resorts, to observe among these "old timers" great reluctance in submitting to medical supervision. In some cases, despite the onset of pulmonary hemorrhage, an active out-of-door existence may for a time remain uninterrupted until the patient of necessity is compelled to yield final obedience. Occasionally, a portion of the responsibility for the evil results must be assumed by the medical adviser, to whose laxity and carelessness is attributable the disastrous delay. Let it be asserted with the utmost emphasis that every case of pulmonary hemorrhage should be regarded as of grave import until its complete arrest, prevention of recurrence, and absence of sequelæ have been determined beyond peradventure, as a result of continuous observation. No matter how apparently insignificant the hemorrhage, loss of blood from the lungs is worthy in all instances of judicious supervision. Several times I have been forced to witness the development of septic bronchopneumonia and death, follow-

ing the initial expectoration of two or three ounces of blood by individuals refusing to yield conformity to the principles of rest and hygienic management. I recall many instances of sudden death from severe hemorrhage as a result of bicycle-riding, driving, and dancing, despite the warning signals displayed by slight initiatory hemoptyses. Small repeated hemorrhages, though not in themselves necessary elements of danger, yet if persistently ignored, represent, like the red flag waved before the approaching train, the existence of possible sources of destruction. An appeal, therefore, is made for at least the tentative enforcement of precautionary measures in all cases of hemoptysis, even if the loss of blood is quite inconsiderable. Among people of this class, in order to secure implicit obedience, the attitude of the physician should often be that of *peremptory command, indomitable patience, and consummate tact.*

The effect of hemorrhage upon another group of patients is quite the reverse of the preceding, there sometimes being produced the greatest possible amount of consternation and dismay. The fears of the invalid may be so exaggerated as to take the form of an almost hopeless and unspeakable terror. This unfortunate mental state is accentuated in many cases by the excitability of relatives. Under such circumstances *prompt and emphatic reassurance* not only represents a prime obligation upon the medical attendant, but constitutes as well a most important feature of treatment. It is eminently good practice to calm the perturbed feelings and restore equanimity of temperament as quickly and fully as possible. A judicious endeavor to assuage the fears of the patient is usually successful in inspiring hope, the establishment of confidence often minimizing to a degree the likelihood of recurrence. It is impossible to overestimate the beneficial effect produced by the kindly encouraging words of the physician at a time of such critical moment. Optimistic cheer should be extended no less in the midst of desperate conditions, than in the presence of smaller hemorrhages. Physicians who, upon words of encouragement, have noted the relieved countenance of the invalid in place of an overshadowing expression of fear and demoralization, will accord hearty support to the wisdom of ever-ready reassurance to patients of this class.

REGARD FOR DETAIL

Attention to infinite detail represents a feature of management of the very greatest importance. It should be remembered that hemorrhagic patients are extremely susceptible to nervous influences, the tendency to bleed being aggravated enormously by slight annoyances and minor physical indiscretions. Thus it is incumbent upon the physician to exercise a strict supervisory control over all that pertains to the invalid and the environment.

It is essential that no person should be allowed in the sick-room besides the nurse, as to whose selection considerable discrimination should be exercised. In addition to perfect familiarity with similar conditions, the nurse must display primarily a ready adaptability to the individual requirements, in order that the sensibilities of the patient be not disturbed by virtue of peculiar idiosyncrasies. Her predominant characteristics should be cheerfulness but firmness of disposition, reticence but courage at times of emergency, scrupulous devotion to detail, and vigilance of observation. If the patient is consigned to the

care of relatives, a painstaking effort should be made in the selection and instruction of the attendant, to the end that a soothing and restful influence surround the invalid at all times. Conversation in the room should be strictly enjoined, the patient being addressed only when necessary and always in words of encouragement. The invalid should not be permitted to reply save in the whispered voice, assent being made whenever possible by a mere nod of the head, as loud talking is often conducive to a recurrence.

The room should be kept at an even, cool temperature, with an abundance of air, but without exposure of the patient to direct drafts. The temperature should rarely exceed 60° F. in the bed-chamber, which should be isolated as much as practicable from other portions of the house. Frequent opening and closing of windows or doors should be prohibited, in order that the element of noise be eliminated to the greatest possible extent. For the same reason the jarring of tables, moving of beds, or rocking of chairs should be restricted.

The patient should remain at all times in the recumbent position, upon a moderately hard mattress, with the head but slightly elevated. In exceptional instances the head and shoulders may be raised slightly, this being justified by severe dyspnea, but permitted for no other reason. The contention is made by some clinicians that the semirecumbent position is more advantageous on account of the added facilities afforded for easy expectoration. With the invalid in the complete recumbent posture, the expectoration may be received into a towel or piece of gauze held by the nurse, with the head of the patient turned slightly to one side. Other physicians advise placing the patient upon the affected side, in order to prevent the return passage of blood into the bronchi of the sound lung, but these conclusions appear more theoretic than practical. As a rule, invalids are able to remain squarely upon the back for *prolonged periods*, but this is not the case if resting upon either side. The act of turning, even with the assistance of the nurse, is often sufficient to induce cough, accelerate respiration, elevate blood-pressure, excite nervous apprehension, and produce hemorrhage. It is difficult to understand why regurgitation of blood into the bronchi of the *sound* lung is *more* to be feared than into the bronchial tract of the affected side. In fact, it would seem that the tendency to bronchopneumonia might be increased by the inspiration of blood in those bronchioles exhibiting previous pathologic change.

A cardinal principle of management should be the absolute maintenance of the patient in a *fixed* position. The arms should remain in a comfortable position by the side, at no time being raised to the head. The knees should not be elevated save during the use of the bedpan. The bed-clothing should be light and consist merely of a sheet and one or two blankets, according to the season. The food should be simple, and consist entirely of cold liquids or semiliquids during the period of greater emergency. Milk, beef-juice, gelatinous preparations, and ice-cream may be given, provided but small quantities are allowed at a time. No articles of diet should be permitted requiring mastication. It is unwise to administer medicine by mouth, for fear of inducing vomiting, with the attendant strong probability of exciting recurring hemorrhages. No remedy save an occasional cathartic is indicated that cannot be administered to *greater advantage* hypodermatically, by inhalation, or by the rectum. In taking nourishment the head should not be raised

from the pillow, the food being given by the nurse either with a spoon or through a drinking tube or cup. Pieces of ice to be held in the mouth may be freely given. This is found to add materially to the comfort of the invalid, to relieve dryness of the buccal mucous membrane, to lessen the likelihood of recurrence, to allay cough, and control nausea.

It is eminently desirable that the bowels be moved once daily, although it must be recognized that *imminent danger* of hemorrhage is induced by the *strain incident to defecation*. Save under exceptional circumstances, particularly the development of renewed hemorrhage, failure to secure a satisfactory evacuation of the bowels once in twenty-four hours constitutes palpable neglect. Inattention to this feature, with the development of fecal impaction, has constituted the turning-point in the destinies of many an unfortunate sufferer from pulmonary hemorrhage. The function of defecation often represents one of the most *important obstacles* in the path of the bleeding consumptive, instances of recurrence during or immediately following the performance of this act, being common in the experience of all phthisiotherapeutists. The difficulties are intensified to a very great extent by the unavoidable administration of opiates.

It is an excellent practice to produce softening of the rectal content by the injection of small quantities of sweet oil. Two ounces may be given in this manner, followed in two hours by a similar amount, and again after an equal lapse of time by an enema of soapsuds and water. Comparatively little or no discomfort is experienced from these injections. If a satisfactory result is not secured by this means, a safe procedure consists of the injection of five or six ounces of the compound infusion of senna, which is also retained, as a rule, without difficulty. If repeated every hour for two or three doses, thorough evacuations are usually secured. In the event of obstinate constipation and abdominal distention high enemata are found to be particularly efficacious. These may consist of two ounces each of a saturated solution of magnesium sulphate, glycerin, and spirits of turpentine, diluted with six ounces of normal salt solution. With some patients recourse must be taken to the mouth for the administration of an effective laxative, the use of magnesium citrate or other alkaline preparations often being followed by satisfactory results. In obstinate cases no agent is so thoroughly and blandly efficient in producing sweeping movements of the bowels as a large dose of castor oil. The natural repugnance of the patient is entirely overcome by administering the oil in a small quantity of beer or slightly flavored effervescent water, but success in this respect depends entirely upon the technic of its administration. One ounce of oil should be placed in a wineglass. The beer or the effervescent liquid should be poured into a drinking-glass, and stirred, if necessary, to promote foaming, when the wineglass containing the oil, should be inverted over and poured into the center of the aërated liquid without touching the side of the glass, and the preparation swallowed without delay. Thus deprived of its disagreeable taste, the oil is rarely, if ever, productive of nausea.

It is, of course, apparent that some modification of stringent detail in the management of pulmonary hemorrhage may be permitted for less urgent conditions, but, in general, a necessity exists for the observance of rigid detailed precautions. For the purpose of illustration the

following case, which has recently come under my observation, is of interest. The patient was found to have experienced a series of hemorrhages during a period of three weeks, and to have become much exhausted, more or less exsanguinated, having an embarrassed respiration, feeble pulse, and daily elevation of temperature. Inquiry elicited the fact that *despite perfectly rational medicinal* management, she had been permitted to sit up in bed during the entire period, to receive callers daily, to engage in trying conversation, to indulge in hearty meals, and to reject the use of the bed-pan. No more striking commentary is needed to verify the assertion that the importance of detail in the management of pulmonary hemorrhage is not always recognized to a sufficient extent.

EXHIBITION OF DRUGS

The employment of drugs for pulmonary hemorrhage has been based, to a great extent, upon their supposed influence in diminishing the *volume* of blood in the lungs, increasing its *coagulability*, or in reducing *arterial pressure* in the pulmonary circulation. Recent experimental research has shown that views previously entertained with reference to the relation of the systemic to the pulmonary blood-pressure, have been erroneous. It has been made clear that constriction of the peripheral vessels is attended by a greater influx of blood in the pulmonary artery, with consequent increase of pressure. Thus ergot and similar remedies possessing styptic qualities through the vasomotor constriction induced, must exert a distinctly unfavorable influence by virtue of the heightened pressure in the pulmonary artery and its branches. Even were such agents known to produce identical effects upon the pulmonary and general arterial circulation, it is extremely doubtful if practical good could be accomplished in an attempt to reduce the volume of blood in the lung, for the accompanying pathologic changes are often of such a character as to prevent the contraction of the vessel at the site of the hemorrhage. All remedies, therefore, calculated to reduce *volume* are not only worthless, but directly harmful. Digitalis may be included in this list, although it may be seriously questioned if, in doses usually prescribed, the present commercial preparation, as adulterated, can exert any influence whatever. At all events, any effect produced by this agent, in the vast majority of hemorrhagic cases, must be *delayed, cumulative,* and *disastrous.*

Wright has shown that the *coagulability* of the blood is increased by the exhibition of calcium lactate and diminished by sodium citrate. Clinical experiments have been conducted in the hope of utilizing the information acquired to the practical benefit of invalids suffering from pulmonary hemorrhage. My own experience with calcium lactate in 15-grain doses, and calcium chlorid in 10-grain doses, has not been such as to establish their clinical value. In some instances vomiting has promptly ensued, and in other cases mild gastric disturbances not properly attributable to other causes. Calcium chlorid given by rectum has failed to yield positive assurance of its remedial efficiency. Gelatin administered hypodermatically may be endowed with some properties tending to increase the coagulability of the blood, but its administration in this manner is exceedingly painful, and attended with the possibility of inducing tetanus. If thus employed, the greatest caution should be

observed in sterilizing the liquid and eliminating commercial impurities. The following method of preparation is reasonably safe:

Sterilized salt solution, 4 ounces; best white gelatin, 1.2 ounces; make slightly alkaline with sodium hydroxid, 1.2 drams. Place in flask with glass stopper and sterilize one-half hour, under steam, for five successive days. If cloudy from alkalinization, it should be filtered until clear. This is to be diluted eight times to make one quart for subcutaneous use.

Gelatin if given by the mouth, can do no harm and possibly some good, but this remains subject to verification. My practice, when using it in this manner, is to give not less than one-third ounce of commercial gelatin daily, but this large amount usually becomes repugnant to the patient within a short time.

Efforts to diminish arterial pressure in the pulmonary circulation by *reducing* the *total volume* of blood are usually irrational, a considerable general depletion having already taken place as a result of the hemorrhage itself. Occasionally, good results may be obtained by moderate venesection, especially when the initial loss of blood is slight, fever persistent, small hemorrhages frequent, and blood-pressure abnormally high. In general, a satisfactory reduction of arterial pressure may be secured by the cautious employment of amyl nitrite, nitroglycerin, or sodium nitrite. These agents produce dilatation of the peripheral arteries, with also a probable reduction of pressure in the pulmonary circulation. It has been claimed by some, that their action upon the pulmonary arteries is that of vasoconstriction, being precisely the reverse of their effect upon the general arterial circulation. Their clinical value, however, seems to be abundantly established, regardless of theories concerning the physiologic action. Amyl nitrite is the most prompt in its salutary effect, but its influence upon the circulation is dissipated within a short time. Its employment should be restricted to the actual period that hemorrhage is taking place, when it may be given by inhalation in doses of from three to five minims. Similar constitutional effects, but of longer duration, may be instituted by the use of nitroglycerin and sodium nitrite. Under the exhibition of these agents a distinct fall in general arterial pressure is usually noted upon palpation of the pulse, as well as by the use of the blood-pressure apparatus. While the tendency to recurrence is undoubtedly lessened under the influence of nitroglycerin, it is often impossible to determine with accuracy the limits of safe and justifiable dosage. Administered in $\frac{1}{100}$-grain doses every three or four hours for a few days according to apparent indications, it is admittedly of some value. Its place, however, in the drug armamentarium of the physician is quite subordinate to that of one or two other remedies.

By far the *most important medicinal* agent in the treatment of pulmonary hemorrhage is *morphin*, the influence of which is directed toward the *relief of cough*, the *calming*, as a rule, *of nervous excitability*, and the *slowing* of the *respirations*. There is also an apparent effect upon the hemorrhage itself. No other drug is endowed with such highly beneficent power, in the treatment of a condition often frightful beyond description, and always distressing to a degree. The measure of its efficacy is entirely dependent upon the intelligence and sagacity of the physician in recognizing clearly the indications for size and frequency of dosage. Of all things, there should not be permitted any adherence to conventionalism in its administration, at a time when the life of the patient is so greatly

contingent upon a judicious conception of the therapeutic relation of cause and effect. It is vitally important that the patient should be kept constantly under the benign influence of the drug, the cough allayed by its soothing effect, and the nervous system subdued to a state of peaceful calm. Sleep is often profound at such times, the respirations are slow, and the likelihood of hemorrhage correspondingly diminished. The remedy should not be administered in stereotyped doses, nor at long, irregular intervals.

The important indications pertaining to the adjustment of dosage consist of the degree of restlessness, the frequency and severity of cough, the recurrence of bleeding, and the rate of respiration. The initial dose should vary from $\frac{1}{8}$ to $\frac{3}{8}$ of a grain, according to the age and the exigency of the condition, but in extreme cases a full grain or more may be given within a relatively short time. Among aged people and children, it should be given with greater caution, as fatal results may follow large indiscriminate doses at both extremes of life. The size and frequency of subsequent doses must be determined exclusively by the effect, thus demanding of the physician the exercise both of courage and of conservatism. Cough must be controlled, bleeding arrested, restlessness assuaged, and the respirations maintained under twenty to the minute, until alarming symptoms have gradually subsided. Nausea, which often supervenes in the event of small haphazard doses given at irregular intervals, completely disappears if the patient is continuously maintained in a condition of moderate narcosis. Upon gradual suspension of the drug no nausea is likely to be exhibited.

Another remedy of exceeding value is atropin, which is particularly advantageous in the more urgent cases. In the event of very profuse hemorrhage, it may be given in an initial dose of $\frac{1}{50}$ grain, to be repeated only after several hours. A suggestion of its good effect is noted in the redness of the skin occasioned by peripheral dilatation incident to vasomotor paresis, with consequent reduction of pressure in the pulmonary circulation. It is unwise, however, to combine injudicious atropin medication with correspondingly large doses of morphin. Upon the development of bronchopneumonia from the inundation of the bronchial tract with inspired blood, the atropin in small doses is of some value as a respiratory stimulant.

Upon the advent of *bronchopneumonia*, which is a most alarming sequel of pulmonary hemorrhage, the morphin should be immediately suspended. At such a time the drug produces harmful results by blunting the cough, which is now peculiarly advantageous. Inasmuch as a cessation of bleeding always takes place with the onset of this much-dreaded complication, the necessity for its administration no longer exists. The remedial indications consist of a prompt exhibition of cardiac stimulants, occasional inhalations of various kinds, a *possible* vaccine or serum therapy, and sometimes venesection and salt infusion.

Among the heart stimulants, strychnin and alcohol should take foremost rank in preference to digitalis, spartein, or adrenalin. Their certainty of action as general or cardiac stimulants is more pronounced, and a broader margin established between therapeutic and toxic effects. Stimulating inhalants are, as a rule, of very doubtful efficacy, though apparently beneficial effects sometimes are noted from the inhalation of turpentine, benzoin, balsam of Peru, phenol, etc. During the severe dyspnea incident to septic bronchopneumonia, inhalations of

oxygen add greatly to the comfort of the patient, though rarely instrumental in the saving of life. Almost insuperable difficulties are found in the way of rational vaccine therapy on account of the frequent impossibility of securing sputum for the making of a vaccine, and the rapid approach of dissolution.

Venesection is permissible in the presence of a laboring or dilated right heart, highly elevated blood-pressure, pulmonary edema, cyanosis, and coma. The degree of temporary improvement is often astonishing and quite beyond the imagination of those unfamiliar with the effect of this procedure in such desperate conditions. Unfortunately, a permanent change for the better is secured in but very few instances. Venesection should be invariably accompanied by the subcutaneous injection of hot salt solution, which is very frequently of value as a cardiac stimulant during the course of the pneumonia. At times of extreme urgency the salt solution may be given intravenously in order to *avoid loss* of *time*, but for *no other reason*, this method being eminently irrational unless the necessity for haste is paramount. Upon three or four occasions I have witnessed sudden death in the midst of this final effort to save life. Upon the other hand, imminent death has been averted in several instances by prompt recourse to salt infusion, particularly during the *collapse* following an *extraordinarily profuse* hemorrhage. I have in mind an experience of several years ago with a patient suffering almost complete exsanguination from a frightful hemorrhage, which took place shortly after arrival in Colorado. In the absence of palpable pulse and during complete coma, with gasping respiration, the salt solution was administered as a last resort by my assistant, Dr. E. W. Emery, and repeated at very frequent intervals with cardiac stimulation and oxygen inhalations during the next few days. Despite active and extensive tuberculous involvement of both lungs, great emaciation, and long-continued fever, the patient, after the lapse of a year and a half, was enabled to engage in an active occupation. During the past two years cough, expectoration, and physical signs have entirely disappeared.

The contention has been made by some that salt solution is contraindicated after profuse hemorrhage, upon the ground that with renewed volume of circulation and increased pressure, the bleeding is likely to recur. A cautiously supervised infusion following drenching exsanguination has never been followed, in my experience, by recurring hemorrhage. It should be remembered that the bleeding often ceases long before death occurs, dissolution taking place from collapse and inability of the heart to contract upon a greatly diminished volume of blood. The deficiency may be supplied by a supplementary infusion of salt solution, while the tendency to thrombus formation, already instituted by the reduction of volume, is in no wise lessened, provided an undue excess of salt solution be not administered.

SPECIAL METHODS

In addition to the use of salt injections, the special measures worthy of trial from time to time, are the *application of cold*, the *employment of traction plasters to constrict the chest*, and the *use of ligatures* upon the *extremities*.

Cold may be conducted to the chest in several ways, *i. e.*, by frequent *application of cloths* previously placed upon blocks of ice, or

saturated with ice-water, by the employment of a *lead coil* through which ice-water slowly flows, and by the use of the *ice-bag*. The objection to the first method consists of the almost *incessant* changing of the cloths, to which the nurse must devote practically her entire time. The chest of the patient is constantly exposed throughout the period during which this method is practised. While perhaps of some value at the time of copious hemorrhage, its practical utility is open to serious doubt at a later period. On account of the unceasing active attendance required, and the incidental manipulation of the patient, it is extremely unlikely that this practice possesses any decided superiority over the use of the ice-bag.

The employment of the lead coil is also attended by some disadvantages. Its weight is sometimes quite objectionable, as is also the necessity of frequent attention to the flow of water. Upon the whole, no special advantages are secured to compensate for the added inconvenience. On the contrary, it is probable that for the average case the inferiority of this method is beyond dispute. Its efficiency has been markedly less in my own experience, than has been reported by others. Considerable difficulty is met in maintaining a close apposition of the coil to the chest wall, on account of the rigidity of the leaden tubes. Failure to secure juxtaposition of coil and soft parts is particularly noticeable among emaciated individuals with shrunken rib-spaces. Under these circumstances, the non-flexible tubes are found to rest here and there upon elevated ribs without sufficient coaptation to the skin to secure practical efficiency. Some of the disadvantages incident to the lead coil are obviated by using a coil of rubber tubing.

All these objections are removed by the intelligent employment of the ice-bag. It is not unduly heavy, as it need not be completely filled with ice. Its use is attended by comparatively no inconvenience, and the cold is applied to the skin without the need of unremitting attention, the patient being quite undisturbed by the ice-bag. Necrosis of the soft parts may be prevented by the intervention of protecting gauze between the bag and the skin. It is, of course, essential that the ice be replenished at not infrequent intervals, as the presence of a rubber bag containing water is not conducive to the best results. Further, the position of the ice-bag upon the abdomen where, owing to the carelessness of the nurse, it too often is found, is not in accord with the principles of its employment. In the same way its application over the lung, from which bleeding does not ensue, is unlikely to exert any direct influence against the recurrence of hemorrhage. Erroneous conclusions as to the particular lung from which the loss of blood takes place are far more frequent than might be supposed. In case both lungs are involved, it is not always easy to differentiate by the physical signs, the unilateral origin of the hemorrhage, nor is it wise in general to examine the chest at this time. If one lung is but slightly diseased and the other unaffected, difficulty in determining the precise area of tuberculous infection is sometimes encountered by inexperienced examiners. I have under observation a patient recently sent to Colorado following a series of small hemorrhages, which occurred during a period of two weeks. Throughout this entire time an ice-bag was kept upon the anterior chest wall of the sound lung, the signs at the other apex having been sufficiently obscure to escape detection. The application of the ice-bag over the heart is often of signal

value, particularly in case of marked arterial excitement. In some cases greater importance may be attached to the position of the ice-bag over the cardiac area, than over the supposed site of pulmonary hemorrhage.

Constriction of the chest by means of tight strapping with rubber adhesive plaster constitutes a not uncommon procedure. As usually employed, overlapping strips are drawn tightly from sternum to spine over the side corresponding to the lung from which the hemorrhage is supposed to take place. The principle invoked is the restriction of respiratory movements as far as possible upon the *affected* side. This curtailment of function is in part compensated for by the supplemental exaggerated function of the other lung. It is at once apparent that, in addition to the impropriety of subjecting the patient at such a time to a physical exploration of the chest, an error in differentiating the site of hemorrhage must be singularly unfortunate in that the sound lung would become crippled in efficiency, while a greater burden would be imposed upon the damaged lung of the unrestricted side. It is not entirely clear that the important underlying principle should be an effort to minimize the use of the affected lung, but rather to *reduce the depth of the respiratory excursion upon both sides.* Equally good results seem to be obtained through the constriction of the entire chest by a single broad strip of rubber adhesive plaster, tightly encircling the ribs below the nipple. A very considerable advantage of this simple procedure is the ease with which the constricting band is applied without appreciable disturbance of the patient. In sharp contrast is the difficulty experienced in applying tightly overlapping unilateral straps, as in this event the patient must be turned upon the side and the traction distributed to less advantage. For the same reason, the employment of ingeniously devised traction plasters designed to restrict powerfully the movements of one side, or to compress pulmonary cavities, are not always of practical value in cases of pulmonary hemorrhage, on account of the difficulties of their intelligent application without undue disturbance of the invalid. If the indications are sufficiently urgent to point to the advisability of retarding the respiratory movements at all, the prime desideratum should be the production of restriction in the simplest possible manner. This is secured with perfect ease by the use of a broad incircling strap of rubber adhesive plaster.

Ligation of the extremities has proved exceedingly effective in the control of alarming pulmonary hemorrhage. While some clinicians have been led to doubt its utility, my own experience has been strongly confirmatory of the claims presented by its early advocates. The method is not to be recommended save in the presence of rather copious hemorrhages, with tendency to frequent recurrence. The ligature should be applied around the limb not far from the trunk, and should be sufficiently tight to compress the veins but not the arterial vessels. The principle involved is the reduction of blood volume in the lung, as a result of preventing the return of the venous circulation in the extremities. Coldness or cyanosis of the hands or feet must, of course, be avoided. In desperate cases it has been my custom to keep the ligature closely applied for much longer periods than usually advised—in some instances for an entire day—without disagreeable result. It is very important that the bandages be removed with the utmost caution, it being urged that they be gently loosened one at a time,

with intervening periods of not less than one-half hour. I recall an illustrative incident, occurring many years ago, when in attendance, throughout an entire night, upon a patient suffering from repeated terrifying hemorrhages during the temporary absence of the attending physician. Ligatures were placed upon all four extremities close to the body and the loss of blood eventually controlled through their influence. The following morning, upon the arrival of the physician in charge, all the ligatures were quickly removed, with an immediate resulting deluge of blood from the mouth of the patient, and instantaneous death.

CHAPTER XCVIII

GENERAL DRUG THERAPY

THE routine administration of drugs to pulmonary invalids, which has been so largely in vogue for many years, has been the immediate cause of an untold amount of harm. The adoption of this pernicious practice in the treatment of all classes, regardless of the character of the remedy or existence of special indications, has been responsible for two conspicuous evils—the directly injurious effect upon the digestive functions, and the enormous *loss of time and opportunity* suffered by consumptives in seeking hygienic, dietetic, and climatic advantages. No words of condemnation concerning the indiscriminate and ignorant employment of drugs can too strongly stamp the disapproval of the profession. There can be no dissenting opinion that the general practitioner should be encouraged to utilize to a far greater extent the facilities for recovery offered by superalimentation, rest, outdoor living, and climate. Furthermore, he should be urged to discard the conventional exhibition of cough syrups, tonics, hypophosphites, malt preparations, and emulsions with which the market is surfeited. Upon the other hand, there should be condemned with equal emphasis the prevailing tendency to decry the administration of any drug whatever, irrespective of its nature and the exigency of the demand. Some specialists in tuberculosis have denied *in toto* the value of medication for almost any aspect of the disease. The former tendency toward the administration of drugs to the exclusion of rational measures has given way to such a *reversal* of sentiment that the use of important remedies to meet urgent symptomatic indications is often met with strenuous objections. To such an extent have the susceptibilities of general practitioners and patients been played upon regarding the supposed disadvantages of all medicine for the consumptive, that an unreasoning prejudice against its employment has become a popular fad. Thus, unnecessary embarrassment is occasioned to the resourceful physician, who seeks to utilize the beneficial effects of judicious medication, in order to control untoward symptoms.

Without desire to condone the ignorance responsible for indiscriminate dosage, the conviction is sustained by practical experience, that an intelligent exhibition of a few remedies to meet the varying needs and requirements of tuberculous invalids is eminently proper,

and constitutes a valuable adjuvant to more important measures. It would seem that quite as much evil may be expected from allegiance to the principles of medicinal nihilism, as from persistent adherence to the old-fashioned doctrine of overmedication. *Protest*, therefore, is offered against the inculcation, in the popular mind, of *delusions* concerning the *non-utility of all drugs* for the pulmonary invalid. To deny their occasional favorable influence in the practice of discerning, discriminating, and resourceful clinicians is as idle as to repudiate the known advantages of hygienic measures and climate.

In the management of *special* symptoms, it has been insisted that the treatment should be conducted along the lines of hygienic methods, but that due recognition should be accorded to the intrinsic merit of judicious drug therapy. The suppression of hemorrhage, the restoration of disordered digestion, and the alleviation of various disturbed functions are often wondrously facilitated by the employment of appropriate medication. It cannot be asserted that equally beneficial results are obtained by the employment of drugs for their *general* effect. In fact, the indications for general drug therapy are exceedingly few and relatively unimportant. In selected cases, however, some value may be attached to the administration of strychnin, arsenic, creasote, and preparations of emulsified fats.

Strychnin is often of advantage through its influence as a general stimulant. In physiologic doses it is supposed to exert an effect upon all body functions. By virtue of its stimulation of the nervous system the activity of the vital processes of cell nutrition are correspondingly promoted. It is thought, with increased functional activity, added defense is acquired against the tuberculous infection. It has been claimed by some that the maximum benefit from the exhibition of this drug, may occur only when the dose is progressively increased to the limit of physiologic toleration. The amounts reported to have been administered without toxic effect by enthusiastic advocates of strychnin therapy for consumptives, almost surpass understanding, in some instances a grain of the drug having been given daily for prolonged periods without unpleasant effects. While it may be accepted as capable of clinical demonstration, that the best effects follow its employment in considerably larger doses than have formerly been given, its routine administration in increasing doses should not be encouraged. It is possible that unusual conditions may exist suggesting the expediency of the maximum physiologic dosage, but the employment of the drug at other times, save to a judicious extent, should be deprecated. Generally speaking, in the absence of special contraindications, good results may be expected among pulmonary invalids by the administration of $\frac{1}{30}$ grain three or four times daily. Under its influence the appetite and general functional activities are often advantageously stimulated.

It has been my custom for many years to combine the administration of arsenic with that of strychnin, although never as a routine procedure. Through the employment of Fowler's solution, which is perhaps the best form for administration, the promotion of appetite is sometimes pronounced. On account of the narrow margin between the therapeutic and toxic doses it is essential that extreme care be exercised in its employment. It should be given in beginning doses of one minim three times a day, which may be cautiously increased to five minims. The remedy

should not be taken in less than one-half glass of water after each meal, and should be promptly suspended upon the appearance of nausea or other disagreeable symptoms. As a rule, it is unwise to persist continuously in the use of this preparation for a longer period than two months, when there may be substituted to advantage agreeable preparations of iron. In the event of dry, spasmodic cough the syrup of hydriodic acid may often be administered with gratifying results.

Unfortunately, creosote has been regarded for many years as of essential value by numerous practitioners. For three-quarters of a century, with varying degrees of enthusiasm, the supposed specific action of this drug has been highly vaunted. Its value at first was thought to consist of a certain inhibiting influence upon the growth of tubercle bacilli, and its greatest efficacy was thought to follow its maximum administration by way of the digestive tract. In the majority of cases it was found that in large doses, the entrance of this drug into the stomach was followed by indigestion, disagreeable eructations, repugnance for food, vomiting and diarrhea, with occasional nephritic disturbance. Routine persistence in its employment despite the manifestations of gastric rebellion, has often resulted in incalculable damage, the initial loss of appetite and digestive derangement apparently becoming confirmed. It must be admitted, however, that in exceptional instances, very material benefit has followed its use, notably an improvement of appetite and digestion and disinfection of the intestinal canal, in cases of flatulence and fermentative diarrhea. Other effects have occasionally been noted among patients with excessive, purulent, and heavy expectoration. It is apparent that in the overwhelming majority of cases, creasote must be regarded as an agent capable of producing a definite amount of harm, but among a comparatively few presenting possibilities of some benefit if intelligently and cautiously administered. For *general use* it cannot be condemned too emphatically, for the unfortunate results far overshadow the isolated instances of improvement. The most that can be said in its behalf is that it has a valid claim for tentative employment among a comparatively few cases. It should be administered, if at all, in small initial doses of not over one or two minims, preferably in capsules, and increased but *moderately*. Its use should be restricted to intractable cases of gastric and intestinal fermentation, with impaired appetite, chronic bronchitis, or bronchiectasis complicating tuberculosis, and pulmonary excavation attended by profuse purulent expectoration. Furthermore, it should be promptly discontinued as soon as it becomes apparent that the appetite and digestion are impaired by the drug. But little confidence may be reposed in its practical utility for the purposes of inhalation. The many derivatives of creasote have been found less advantageous than the crude article.

Several preparations of cod-liver oil and easily digested fats must be accepted as possessing certain advantages for a *class* of pulmonary invalids. The only benefit represented by the administration of such agents, is reflected in the ingestion of a generous amount of easily digested fat. Much discrimination should be exercised in the employment of these preparations on account of their frequent effect in retarding digestion. Obviously, they should not be given to patients with fever and pronounced gastric derangement. In general, they are borne much better in the winter than during the hot summer months. Their special

utility is found in the treatment of individuals who, on account of straightened financial circumstances, are not favored by an overabundance of good nutritious food. Thus these preparations have been of considerable service, chiefly among dispensary patients, and other consumptives, but sparingly endowed with this world's goods. The necessity for their employment is much less when the patient is supplied with large quantities of cream, butter, and eggs.

SECTION III

SPECIFIC TREATMENT

CHAPTER XCIX

THEORIES OF IMMUNITY

THE underlying principle, upon which have been based all efforts in the way of biologic therapy in tuberculosis, is the production of artificial immunity by the introduction, into the body, of some bacterial agent stimulating resistance to infection. It is becoming established that effective means are available for the *reinforcement* of the natural but complex processes of immunity. The present recognition of the possible stimulation of the defensive resources of the organism by artificial means, has been of slow development, but the overwhelming logic of experimental research and of clinical experience appears to be well-nigh irresistible. It can no longer be disputed that in many instances, through the employment of immunizing substances, results of considerable value may be achieved. In conceding the clinical efficiency of specific medication as at present employed, a tribute of the highest honor should be paid to the numerous workers through whose indefatigable labors in the midst of almost insurmountable obstacles, the evolution of our present knowledge has been made possible. Before proceeding to the clinical application of the principles upon which depend the production of an artificial resistance to tuberculous infection, it is well to present a brief historic sketch of the various experimental contributions bearing upon the relation of culture products to immunity.

The first endeavor to produce an artificial immunity to tuberculosis originated with Koch, who observed essential differences following the inoculation of pure cultures of tubercle bacilli in healthy and in tuberculous guinea-pigs. In the former the sequence of local changes consisted of apparent healing, the formation of a hard nodule in ten to fourteen days, and a subsequent persistent ulcer until the death of the animal. In pigs already tuberculous, there was an initial attempt at healing, followed shortly by necrosis of skin and superficial ulceration, which soon healed permanently. Dead bacilli were found to produce no general effect when injected into healthy animals, but prolonged the life of those

already infected. As a result of these experiments, tuberculous animals were assumed to acquire immunity against reinfection, but there was no evidence pointing to a successful resistance of the previous infection. It was apparent, however, that some specific influence was exerted by the products of the dead tubercle bacilli.

Tuberculin, which was reported to the profession by Koch in 1890, was at once hailed as a specific, and widely administered. It was made by evaporating glycerin bouillon cultures of the tubercle bacillus in a water-bath to one-tenth of its volume. The dead bacilli were filtered, the tuberculin in the filtrate containing 40 to 50 per cent. of glycerin. When dilutions are made of this product, phenol is added for the purpose of preservation.

A brief résumé of the more prominent effects of this agent is of some interest, though familiar to all students of immunity. Curiously, it was found in small doses to exert but little influence in well people, but to produce striking phenomena in the tuberculous. The innocuousness of its administration to healthy individuals has been ascribed, according to Flexner and others, to a *combination* of the active principles, from which the toxic substance is incapable of separation, save in the tuberculous foci of infected individuals. Ingenious as is this explanation, it is difficult of reconciliation with the known fact of its profoundly poisonous influence in the non-tuberculous, if given in doses somewhat larger than employed for those already infected. It was found to produce, after a few hours, severe constitutional symptoms, consisting of chill, headache, vomiting, high fever, rapid pulse, prostration, and sweating. The convalescence, as a rule, was prompt. Among patients with even slight tuberculous involvement similar effects, known as the *general reaction*, followed much smaller doses. In circumscribed or external tuberculous processes a more or less defined *local* reaction was observed, consisting of pain, swelling, tenderness, and visual engorgement. In some cases of pulmonary phthisis, cough was temporarily aggravated, and complaint made of soreness or tightness of the chest, with shortness of breath. Hemorrhage sometimes ensued a few hours after the injection, but this was not usually attended by serial recurrences. Areas of increased dulness were occasionally recognized, together with added moisture in the finer bronchioles. The violence of the general reaction was often greatly disproportionate to the local evidences, but the latter sometimes resulted without symptoms of constitutional disturbance. Marked differences existed in the susceptibility of individuals and of the same person at various times. Repeated inoculations appeared to confer a striking indifference on the part of the organism to subsequent injections, but increased susceptibility to reaction returned after discontinuance of the injections.

Incalculable damage was inflicted by its reckless employment by inexperienced clinicians, and in some instances from its administration even by well-trained observers. Failure to demonstrate its practical value, together with the popular recognition of its disadvantages, speedily resulted in an era of violent condemnation. During a period of fifteen years, from 1890 to 1905, the wave of repudiation increased in volume and power until its effect appeared almost overwhelming.

In the mean time, through an appreciation of its complex but subtle influence upon tuberculous processes, many students were inspired to continue investigations in the hope of discovering a modified tuberculin

that would yield satisfactory results. Numerous preparations were used in an effort to produce among animals artificial immunity to a subsequent tuberculous infection. These were also employed to a wide extent as therapeutic agents. Koch, in an endeavor to make a preparation containing the toxins of the bacillus suitable for therapeutic employment, presented the tuberculin TR. Virulent cultures of tubercle bacilli, after being dried in vacuum, were thoroughly pulverized. Upon the addition of distilled water, centrifuging was employed for three-quarters of an hour at the rate of 4000 revolutions to the minute. The white, opalescent fluid in the upper portion was designated TO, and the slimy residuum, TR. The supernatant fluid was aspirated, the residuum mixed with more distilled water, and the centrifuging process repeated. The tuberculin TO represented the soluble components in glycerin and was similar in its effect to the old tuberculin. The TR contained the insoluble parts in a fine emulsion, representing all the immunizing substances, and was capable of absorption. To this 20 per cent. glycerin was added. His more recent preparation is the bacilli emulsion, which is a suspension of pulverized bacilli in water with an equal amount of glycerin. This was presented to the profession in 1901. A variety of agents, all of which comprise some modification of the original tuberculin, were advanced by Klebs, Maragliano, Hirschfelder, Hahn, Landmann, von Ruck, and Behring. It was found that the injection of pulverized living or dead bacilli produced for a time an increased resistance to tuberculous infection, but not sufficiently to withstand completely a previous bacillary invasion. In other words, the relative immunity produced was not permanent nor especially pronounced.

It became quite definitely established that immunity could be conferred upon some animals by inoculation with living attenuated tubercle bacilli. Dixon, in 1889, in experiments upon guinea-pigs and rabbits, found that, after inoculation with cultures of slight virulence, an apparent immunity from subsequent infection was secured. In 1890 and 1891 experiments of this nature were performed by Martin, Grancher, Ledoux-Lebard, Courmont, Dor, Hèricourt, and Richet, in some instances use being made of attenuated human bacilli, and in others, of the avian variety.

The experiments of Trudeau in 1892 and 1893 are of great interest and have often been quoted. Rabbits were inoculated twice with avian bacilli, three weeks intervening between the protective treatments. Some months later the anterior chamber of the eye was inoculated with virulent mammalian bacilli, it being uncertain whether the cultures were of human or bovine type. In the control animals a slowly progressive degenerative change took place in the eye, resulting in its ultimate destruction. Among those previously treated with avian inoculations, the inflammatory changes were manifested much more rapidly, but were correspondingly quick to subside, disappearing altogether after a few weeks.

DeSchweinitz, in 1894, inoculated guinea-pigs with an attenuated culture of human tubercle bacilli cultivated for twenty generations. This was not found virulently infective to these animals, but afforded an undoubted protection against further inoculation, as was shown when they were later subjected to the injection of virulent bovine bacilli. These remained unaffected while the control animals survived but six or seven weeks.

In 1903 Trudeau continued his investigations upon guinea-pigs, in an effort to determine whether his previous satisfying attempts toward the production of artificial immunity, were referable solely to the injections of the living bacillus. He, therefore, in his later experiments, made use both of living attenuated human cultures, and of dead bacilli previously subjected to steam sterilization for fifteen minutes. A second inoculation was performed one month later. At this time a slight enlargement of the inguinal glands was noted in those receiving attenuated living bacilli, while the animals inoculated with dead bacilli were apparently unaffected. In another month all were subjected to inoculation with virulent human bacilli, together with an equal number of controls. All the latter were dead in ninety days, exhibiting upon examination extensive general infection of organs. A considerable number of the animals inoculated with dead bacilli had also succumbed, but this was not true of a single pig injected with attenuated living cultures. The pathologic changes in the control animals were very similar to those in the pigs inoculated with dead bacilli. On the other hand, the pathologic lesions in those injected with living bacilli were comparatively insignificant, there being no evidence of caseation.

Great interest attaches to experiments performed upon cattle in an effort to produce artificial immunity. Much work has been done and results reported by MacFadyean, Behring, Pearson, Gilliland, and others.

MacFadyean, early in 1901, after intravenous inoculation of several cattle, two of which were tuberculous, with living cultures of tubercle bacilli, found that their resistance to infection was remarkably increased. Later in the same year Behring began experimental work upon a large scale, with a view to produce artificial immunization of cattle. After having secured rather indifferent, if not entirely unsuccessful, results from the use of tuberculin and its modifications, he succeeded in immunizing these animals with attenuated cultures of living tubercle bacilli of bovine origin. A culture of human bacilli of low virulence was given to many cattle, and followed by another of increased activity after a few months. It was found that an enormous tolerance to virulent tuberculous infection from the bovine bacillus was established. Inoculations with such infective material were usually attended by no appreciable results, while control animals unprotected by previous inoculation succumbed in a few weeks. The duration of the period of immunization has not been definitely determined. Pearson has shown conclusively, from references contained in an exhaustive and valuable article recently published, that Behring's belief concerning the prolonged duration of the immunity has not been supported by subsequent facts in many instances.

Recently experiments have been made at Melun, in the Department of Seine et Marne, by Vallé. In February, 1905, Dutch cows, Limousin bulls, and Normandy cattle, all young and healthy, were treated by injections of a vaccine prepared by Vallé in accordance with Behring's method. In the following June all were subjected to inoculation with virulent bovine cultures. Seven of the same age and race were inoculated subcutaneously, as were an equal number of controls. In one month all the control animals exhibited extensive tuberculous change, while only one or two of those vaccinated, exhibited even the slightest trace of infection. Six others were inoculated intravenously. The vaccinated animals remained apparently unaffected, while the controls became

seriously ill, three dying within two weeks. Another set of animals were placed side by side with tuberculous cows in the same shed and inclosure. Resistance to infection was found in those protected by previous inoculations, while advanced tuberculous change was recognized at autopsy among the controls. It is of further interest to note that immunization of cattle through the digestive tract has been reported. Roux and Vallé have very recently recorded experiments of this nature. Cultures of living tubercle bacilli were fed sparingly to young calves, and the reported resulting immunity was shown by the tuberculin test. Calmette and Guerin have reached the same conclusion as to the production of immunity through the alimentary tract.

The experimental investigations thus far reported have been sufficient to demonstrate beyond question the active protective influence resulting from inoculations of living attenuated cultures of tubercle bacilli. It has also been shown that injections of dead bacilli in animals do not exert more than a fleeting or partial immunity.

The early researches of Koch in connection with tuberculin, and of other workers upon its various modifications, prepared the way for a recognition of the increasing tolerance established for bacterial toxins. There was suggested the possibility of securing an antituberculin or antitoxin capable of neutralizing the tuberculosis toxins. It was not altogether appreciated that the bacterial toxins of tuberculosis were but partially soluble in the blood, and that they remained more or less inwrapped within the solid substance of the parasite. It was assumed that diffusion of the bacterial poison in the fluids of the body took place in tuberculosis as in diphtheria and tetanus. Numerous methods were employed, and various animals utilized, in an endeavor to secure a supposed immunizing influence from the blood or the blood-serum.

Maragliano found that the tuberculin reaction could be considerably diminished, if not prevented altogether, by the simultaneous administration of the serum of animals to whom the agent had previously been given. This and similar experiences by others with the serum from various inoculated animals, were attributed to the presence of an antituberculin. The so-called antitoxins were prepared in various ways, but the claims made concerning their merits by their several advocates, have been unsustained by animal experimentation or clinical observation.

In the meantime Arloing and Courmont called attention to a peculiar effect produced upon tubercle bacilli contained in bacilli emulsion, by the serum of tuberculous individuals. A clumping of bacilli was recognized under these conditions, and the reaction was termed the agglutination test. The clumping of bacilli is more properly a sedimentation or precipitation, as the bacterial emulsion undoubtedly holds some of the toxins in solution, and tuberculin injections are known to increase the precipitating power of serum. Baldwin has shown that the injection of tuberculin into rabbits is followed by a high degree of precipitating power of the blood-serum for the tuberculin, and by an increased agglutination capacity for bacilli emulsion.

For many years Maragliano has devoted much patient study to the subject of serum-therapy for pulmonary tuberculosis. He has made use of the serum of animals previously injected with toxins and the bodies of dead bacilli. He has contended, since 1895, that a serum could be produced "rich both in antibodies and antitoxins." The

proportion of these substances is subject to much variation in different sera, and depends upon the manner of inoculating the producing animal. The amount of antitoxin is increased if the animal is treated with toxins, and the number of antibodies, if treated by the watery extract from the bacilli themselves. His doctrine of defense consists of the formation of antibodies and the consequent power of agglutination. He regards the agglutinating power as a measure of the antibodies. This reaction, which is regarded by Koch as the earliest indication of approaching immunization, is believed by Maragliano to correspond to the development of bactericidal properties of blood-serum. The latter is subject to precise determination by his method of showing an attained immunization. The animal is subject to repeated immunizing injections until the serum (which is subsequently standardized) is found to exhibit a sufficiently high power of agglutination. He asserts that new antitoxins and new antibodies are produced by the introduction of the serum into the human organism, and that they supplement the natural resisting processes. He concedes that the general organism of itself is responsible in large measure for the increase of the defensive process in the blood, and hence that best results can take place only when the disease is not far advanced, general nutrition not greatly impaired, and mixed infection not pronounced.

Prior to the discovery of the tubercle bacillus, there existed widely prevalent ideas as to the production in man of varying degrees of immunity to tuberculosis from the preëxistence and coëxistence of certain other diseases, notably, scrofula, asthma, chronic bronchitis, and forms of heart disease associated with venous congestion of the lungs. The resistance of the body to tuberculous infection in the midst of these conditions, was not wholly ascribed to the influence of local processes rendering the soil unreceptive to a deposit of tubercle, but rather was attributed to a certain *antagonism* between the diseases in question. Even in scrofula, which was recognized to possess some relation to pulmonary phthisis, there was exhibited a certain stubbornness to general tuberculous involvement, suggesting a form of systemic resistance.

Later statistical observations tended to confirm the early supposition that a natural immunity was conferred upon a number of people by the very presence of a tuberculous affection. This was illustrated in the low mortality-rate of tuberculosis in comparison with its high morbidity. The fact that from 85 per cent. to 95 per cent. of the human race have been at some period of life the subject of tuberculous infection, as demonstrated by autopsy findings, and that only one person in seven succumbs to the disease, was indicative of a local tissue resistance, affording presumptive evidence of a general tendency of the organism to withstand advancing infection. Clinical experience has demonstrated from time to time an *increased* resistance to infection accompanying the development of *localized* tuberculous processes, a remarkable inhibitory influence upon the progress of pulmonary phthisis sometimes being noted under these circumstances. I recall several instances of tuberculous involvement of joints, bones, glands, kidneys, and epididymis, and particularly cases of spinal caries, with the onset of which, there was exhibited an immediate and continuous retrogression in the activity of the pulmonary disease. This coincidence has been so frequent as to admit of no doubt concerning the increased general resistance often accompanying, if not occasioned by, the local affection. Such clinical phenomena are strictly in accord

with Wright's doctrine, as to the stimulated machinery of self-immunization by the entrance into the circulation of a not undue amount of the toxins emanating from the site of local infection.

The protective influence resulting from injecting attenuated cultures of various forms of bacteria was recognized by Pasteur in 1879, and constituted the first important advance toward the experimental production of biologic immunity. The well-known doctrine of phagocytosis, promulgated by Metchnikoff in 1882, related to the conflict between the invading parasites and the army of defense composed of leukocytes. The rôle of the latter was supposed to consist of the attack upon foreign elements, and their subsequent inglobement and digestion. It was conceived by Metchnikoff that there existed in certain sera, substances capable of enhancing the phagocytic powers of the leukocytes. To these substances the term "stimulins" has been applied. Phagocytosis is known to vary in accordance with the existence of cellular attraction or repulsion. This theory of chemotaxis, evolved by Pfeffer, the botanist, was extended by Metchnikoff to apply to his hypothesis concerning the phagocytic power of the white cells. The presence, respectively, of a positive or negative chemotaxis as a determining factor in the production of phagocytosis, was resourcefully accepted by Metchnikoff to be a fundamental principle of his doctrine, a positive chemotaxis being assumed as a basic condition for the formation of phagocytosis.

Other theories of immunity have subsequently been advocated, and much experimental evidence presented to establish their correctness. Some of these appear inherently opposed to the doctrine of phagocytosis, some capable of a reconcilable interpretation with this theory, and others of an entirely independent relation. It is impossible, in this connection, to discuss the theory of Ehrlich, the demonstrator of the mechanism of antitoxins, of Behring and Pfeiffer, the discoverers, respectively, of antitoxin and the bacteriolytic action of immune blood-serum, nor of Gruber and Widal, the orginators of the agglutination tests. All point to the irresistible conclusion that the human body possesses means of defense other than obtain alone from the phagocytic action of the leukocytes. Ehrlich advanced the theory of a biologic union of the bacterial toxins and the receptor cells of the individual, as an essential condition of actual toxemia. As a result of this union of the haptophores, the reaction takes place in the affected receptor cells, which are stimulated to make an excess of similar groups, constituting agents of defense and called antitoxins. Unfortunately, the practical application of the principles of antitoxic immunity in pulmonary tuberculosis are unsatisfactory on account of the insolubility of the toxins in the blood. The tubercle bacilli and other pathogenic bacteria commonly present in tuberculosis retain their toxin, or more properly endotoxin, closely inwrapped within the protoplasmic body.

In this connection the work of Pfeiffer, with reference to bacteriolytic action, is of considerable interest. Bacteriolysis is thought to be attended in some instances with such a liberation of the endotoxin, that the disintegration of the bacilli may not only afford no protection against the toxin, but possibly may even increase systemic intoxication. The tubercle bacillus has been found to respond to no bactericidal or bacteriolytic action of the blood, and, generally speaking, to no antitoxic influence, after the manner of diphtheria and tetanus. In the light of recent investigations, it is apparent that in tuberculosis, phagocytosis still

remains a most important element in the production of immunity. The degree of phagocytosis, however, is dependent upon conditions other than the simple presence of a positive chemotaxis. Substances are known to exist in the blood which exert a predominant influence upon the phagocytic action of the leukocytes. This power of defense by the organism is found to vary according to the effect of certain preparatory substances upon the bacilli, increasing their susceptibility to the action of the white cells. According to Potter, the earliest demonstration of an increased phagocytosis referable to alterations of the microörganism, was made by Denys and Leclef in 1895. This was followed by considerable experimental work by Bordet, Mennes and Leishman, Wright and Douglass, Neufeld and Rimpau, Bullock, Western, Ruediger, Sawtchenko, Dean, and Hektoen. All agreed as to the specific effect of the serum upon the microörganism and its essential rôle in the production of phagocytosis. Potter has recently shown that the phagocyting power of corpuscles taken from a diseased person is considerably less than that of corpuscles from a supposedly healthy individual. Thus, in *addition* to the differences in *normal sera, variations* are found in the phagocytic activity of leukocytes of patients subjected to *bacterial infection* and *individuals apparently well.* Potter has suggested, as a result of his observations, that during a severe infection, the phagocytic power is disproportionately lower than the opsonic index of the serum, and upon recovery the defensive activity of the leukocytes, in comparison with the corpuscles of normal individuals, enhanced more noticeably than the opsonic power.

The term "opsonin" has been applied by Wright to the substance *preparing* the microörganisms for phagocytosis. As mentioned previously, there are *other* elements involved in the mechanism of immunity, *i. e.*, the agglutinins, the bactericidal substances, the bacteriolysins, and the antitoxins. In recognition of the action attributed to these substances, all may be grouped under the term "bacteriotrophins." Wright, modifying the nomenclature of Ehrlich, speaks of the products of immunity generally as antitropic elements or antitropins. The source of the opsonins in the blood is unexplained, but Wright believes that they are stimulated locally, hence the expediency in tuberculous glands and lupus, of injecting vaccines near the site of infected processes. Hektoen and Ruediger, in 1906, showed that a lytic action without opsonic power can exist in normal serum and vice versâ. They also showed that immunization may be attended by opsonic action without agglutination or bacteriolysis.

It has been claimed by Wright and his school that a separate opsonin exists in the blood for each variety of microörganism. An elaborate and technical method for the precise determination of the opsonic power of different individuals at varying times in relation to the several forms of bacterial invasion has been advanced by Wright. The amount of opsonins present to combat a single infection may be widely at variance with the extent of opsonic action against other bacteria. Further, the quantity of opsonic substance within the blood is known to vary considerably in the same individual from time to time under differing conditions. These conditions relate not only to external factors, such as exercise, excitement, food, etc., but also to varying changes within the body. In other words, there is going on at different times a distinct effort on the part of the

organism toward self-immunization, which process is subject to remarkable fluctuation in accordance with certain pathologic and physiologic conditions. In accordance with the law of biologic immunity, when bacteria or their poisons are introduced into the system, the response of the organism consists of the elaboration of protective substances against these invaders. The mechanism of defense relates to the action of agglutinins, lysins, bactericidal substances, antitoxins, and opsonins. Under *some* circumstances the tuberculous individual develops resources of defense unattained by those not thus affected, and in *other* instances awaits *artificial aid* to immobilize a waiting army of defense. It may be that even an *excess* of poisons exists in the body to start the machinery of immunization, but is incapable of *utilization* by virtue of being locked up within foci of infection by heightened bacteriotrophic pressure. Thus artificial excitation of the protective processes remains to be secured by the introduction of bacterial agents. In other cases an overproduction of poisons emanating from centers of infection is attended by a diminished opsonic power. It is thus apparent that the maximum amount of opsonins is to be acquired neither from a paucity nor a surplus of toxins, but rather from such a dosage at different times as will supply the deficit in the working capital of the individual, whose *unaided* resources of a toxic nature are insufficient for the maintenance of satisfactory immunization.

In some chronic infections, where a lowered bacteriotrophic pressure continuously prevails, Wright is of the opinion that the introduction of a suitable vaccine acts as a stimulant to the dormant processes of immunity. The opsonins are often subject to much variation, according to the inflow into the circulation of the bacterial products, whether they are present during the course of the disease or are introduced for therapeutic purposes. In tuberculosis the inflow of tuberculo-opsonic substance is by no means constant. Some patients are continuously overinfecting themselves from numerous foci, and others persistently suffering from deficient stimulating toxins. Wright's practice consists of an attempted *regulation or adjustment* of the amount of protective poisons by means of carefully estimated and properly interspersed doses of artificial vaccines, based upon the frequent estimate of the opsonic power. He has demonstrated a certain definite sequence of changes in the opsonic action after the injection of vaccines. Following this injection there is induced a phase in which the protective substances in the blood, opsonins, agglutinins, etc., are diminished—the so-called negative phase. This is followed after a longer or shorter period of time, according to the size of the injection, by a rise in the amount of protective substances—the so-called positive phase. During this time phagocytosis is markedly stimulated. This cyclic variation in the amount of protective substance in the blood is termed "the law of ebb and flow and reflow, and the maintained high tide of immunity."

Successful results of inoculation depend greatly upon the adaptation of the size of the dose to the needs and requirements of the general organism. The excursion of the negative and positive phases is dependent not only upon the quantity of vaccine introduced, but also upon the original amount of opsonins present. Thus a small dose in case of a relatively high opsonic power, may produce but slight, if any, negative phase, and a correspondingly insignificant positive reaction. A similar dose, given in the presence of a much diminished opsonic power, may be followed

by a more pronounced negative disturbance, and, up to a certain point, a proportionately greater positive phase. If, however, a large amount of toxin be injected, the negative phase may approach to a condition of collapse and be attended by severe constitutional disturbance, persisting for a prolonged period and not followed by any positive phase whatever. It will be seen that the very essence of the method consists of an approximately accurate estimate of the deficit in opsonic resources, and the effort to supplant the natural protective forces by carefully adjusted artificial dosage. By injudicious injections the natural forces of defense may be supplanted altogether, thus destroying, by artificial means, the very efforts toward self-protection. With diminished resistance through continuous indiscreet inoculations, a large dose administered during the negative phase or at the time of low opsonic power, may culminate in such depletion of protective elements as to overwhelm the individual.

By the use of suitably prepared vaccines the bacteria within the system are rendered more susceptible to phagocytosis. The vaccine in all cases of bacillary invasion save that of tuberculosis should be prepared from the particular strain of bacterial infection present in the individual to whom it is to be administered. It is probable that in tuberculous affections the best results may be attained by the use of homologous vaccines.

In case of pure tuberculous infection without constitutional or bacteriologic evidence of secondary invasion by a variety of pathogenic bacteria, the toxic agent generally employed for practical therapeutic purposes is Koch's bacilli emulsion, the new tuberculin. In the event of mixed infection in pulmonary tuberculosis with considerable temperature elevation it is often inexpedient to attempt an increase of the *tuberculo*-opsonic power on account of the fluctuating toxic infection, which precludes any effort in the way of artificial adjustment. In such cases I have sometimes been able to secure satisfactory results by the use of homologous vaccines. Clinical observations of this nature will be later reported. The vaccine directed toward the relief of the secondary infection is obtained from the sputum of each invalid for whom the agent is to be employed.

The technic of this preparation, as performed by Dr. W. C. Mitchell, according to Wright's method, is as follows:

After sterilization of the mouth and throat with a saturated solution of boric acid, the sputum is deposited directly from the mouth into a sterilized bottle. A portion of the sputum is separated from the interior of the mass and carefully teased in a sterile Petri dish with sterile forceps or platinum loops. This mass is rubbed upon the surface of a blood-serum culture-medium and the process continued through a series of five or six test-tubes, the loop being sterilized between each inoculation. After subjection to a temperature of 37° C. in the incubator for one or two days, the various isolated colonies of bacteria are recognized in the fourth or fifth tube. From these tubes they may be separated into individual cultures by transference to other tubes of culture-media and incubated. After thus securing pure cultures of the microörganism, the culture is scraped with a glass rod or a platinum loop into a small amount of sterile salt solution, making a bacterial emulsion. This is placed in a sterile test-tube which is drawn out to a fine point and sealed. It is then shaken for fifteen minutes in order to break up the clumps. To determine the strength of the preparation one volume of blood from the finger is mixed with an equal quantity of the above bacterial emulsion, and diluted with three volumes of normal salt solution. After smearing, fixing, and staining the ratio of microörganisms to the red blood-cells is computed from the study of a number of fields. The examiner is enabled to determine the number of bacilli in a unit of volume by the known

number of red cells in a cubic millimeter. Thus the proportion is as follows: The number of red blood-cells in a given number of fields is to the number of bacilli in the same number of fields as 5,500,000 red blood-cells (Colorado altitude) is to *X*. *X* equals the number of bacilli in a cubic millimeter. From this the number of bacteria in a cubic centimeter is obtained by multiplying the number in a cubic millimeter by 1000. The test-tube containing the bacterial emulsion is again sealed and placed in the hot-water bath at 60°–62° C. for one hour. It is necessary to destroy the vitality of the microörganisms but to preserve at the same time their toxic properties. Too short a period of sterilization will fail to kill the bacteria, while if this is too prolonged the preparation will be rendered inert. After the process of sterilization is completed the bacterial emulsion is diluted with sterile salt solution, and a computation made of the number of bacteria in each cubic centimeter. Control cultures are made in all cases to demonstrate that the vitality of the bacteria is actually destroyed. The tubercle bacilli vaccine, in contradistinction to the above, is estimated by weight rather than by enumeration, and is given in initial doses of from one ten-thousandth to one one-thousandth of a milligram.

The determination of the opsonic power of an individual consists of an estimate of the relative number of bacteria ingested by washed white blood-cells under the influence of the *patient's* serum, in comparison with the number ingested by the same number of cells in the presence of *normal* blood-serum under precisely similar conditions. It follows, therefore, that as essential factors there must be *blood from the patient; blood assumed to be normal;* and *washed leukocytes*. In addition, there must be at hand an emulsion of the specific bacteria concerning which the opsonic action is sought. After cleansing of the finger the patient's blood is withdrawn by means of capillary attraction into the curved extremity of a glass capsule, the fine capillary ends of which have been broken. The straight end of the capsule is sealed by holding in a mildly burning flame. It is important to have the flame hot enough to seal the end of the tube quickly, in order to avoid heating that portion of the capsule containing the blood and thus modifying the opsonic power. If the straight end of the capsule is not too short, the bulging portion wherein the blood is to be shaken from the curved extremity is not likely to be heated by the sealing of the other end. Should this take place, a portion of the blood is forced from the curved end by the expanding air within the tube. The blood is to be shaken from the curved extremity into the bulging portion. Pouring of cold water upon the distal or straight end produces such contraction of air as to draw the blood quickly beyond the elbow. The normal or control blood is obtained in the same manner. The two capsules, after identification marking, are allowed to clot and are then centrifuged in order to separate the serum. The ends of the capsule are broken and the serum is ready for extraction with a fine pipet.

The washed leukocytes are prepared as follows: About twenty large drops of blood are placed in several times this volume of normal salt solution, containing 1.5 per cent. of sodium citrate. After thorough mixing and centrifuging the supernatant liquid is aspirated with a fine pipet. Normal (85) per cent. salt solution is added to the corpuscles to remove traces of serum. The process of centrifuging is repeated, and the supernatant liquid again separated. Thus the serum is removed and the blood-cells remain in the bottom of the tube, the leukocytes forming the superficial layer or cream. To produce the bacterial emulsion the cultures are diluted with a small amount of salt solution until a milky appearance is secured, and are centrifuged in a small tube to throw down the clumps.

A commercial product of tubercle bacilli emulsion may be secured containing a suspension of bacilli in glycerin. This is washed off by salt solution, filtered, and the residue ground with 0.5 per cent. salt solution until a milky emulsion is produced. The essential constituent factors are now ready for utilization. Fine capillary pipets, made after the direction of Wright, with an even caliber, are marked in such a way as to designate a fixed volume or unit of measure. An equal volume of washed leukocytes, patient's serum, and bacilli emulsion are withdrawn into the same pipet and deposited upon a sterile slide for the purpose of more thorough mixing. The combined liquid once more is drawn into the pipet which is sealed and placed in the opsonic incubator for fifteen minutes at a temperature of 37° C. An identical process is pursued with the normal blood. After the incubation period is finished a film or smear is prepared in each instance upon a slide in such a manner as to insure even distribution. The specimen is now ready for staining, carbol-fuchsin being used for tubercle bacilli and the so-called Leishman stain, consisting of eosin and methylene-blue, for nearly all others. In lieu of Leishman's stain the specimen may be fixed with a saturated solution of corrosive sublimate and stained with thionin or any suitable anilin dye.

After selecting a proper field with the low power the oil-immersion lens is used to count the number of microörganisms found in each of 50 to 100 polymorphonuclear neutrophiles. The average number of the bacteria contained in the whole number of cells counted, constitutes the phagocytic index. This, for the normal blood, is regarded as unity, though some variation exists among healthy individuals. The phagocytic index of the patient as compared with that of a healthy individual gives the opsonic index. Thus, if the average number of bacteria contained within a given number of normal blood-cells is eight, and the number in the blood of the patient is four, based upon the count of an equal number of cells, the opsonic index would be one-half that of the normal and would be expressed as 0.5.

The opsonic index, as previously stated, is subject to considerable variation in different individuals suffering from the same disease, and in the same person according to the degree of systemic infection, and as claimed by some according to certain external conditions, as exercise or excitement. If the index of any given microörganism is continuously low, it is assumed that there exists a localized focus of bacillary invasion. If the index is high above unity, or if a decided fluctuation is found in successive examinations, the evidence points to a pronounced systemic infection. It is suggested, therefore, that repeated observations of the opsonic index should possess a considerable degree of diagnostic merit, and afford approximate indications with reference to vaccine therapy.

There has been much convincing testimony presented by Wright and his followers concerning the practical utility of his method of attempted artificial immunization. The general consensus of opinion among scientists and clinicians is to the effect that *vaccine medication* is founded upon rational grounds and is destined to represent a great advance in the therapy of the future. The *precise regulation of the dosage*, based upon the *determination of the opsonic index*, however, is open to controversy. Adverse opinions are freely expressed concerning the general impracticability of his work, on the score of the many opportunities for error and confusion in the detailed application of the intricate technic. In *addition* to the difficulties attending the technic, due cognizance should be taken of the possible sources of error inherent to *differences* in the *susceptibility* of the microörganisms to agglutination in a comparatively large volume of serum, and to the *variations* in the effect of the pathologic sera upon normal phagocytes. It does not follow, however, that for *these reasons alone* the method of Wright is unworthy of recourse by those qualified, through training and equipment, to take advantage of his contributions.

Wright and Bullock have called attention to one of the difficulties in securing immunization in pulmonary tuberculosis from the employment of tuberculin. They attribute considerable importance to the histologic and pathologic structure of the pulmonary tubercle as offering a barrier to the antibacterial forces of the organism. They believe that the toxins, otherwise stimulating to the machinery of immunization, are locked up within these foci of infection, and, *per contra*, if artificial aids to the immunizing process are introduced into the circulation, that the bacilli remain protected to some extent behind a wall of non-vascular connective tissue. It thus appears that inoculations with bacilli emulsion are regarded as *dangerous* for one class of consump-

tives suffering from an *excess* of toxins, and as *non-effective* on account of structural conditions for those exhibiting a *deficiency* of these protective substances. This hypothesis of the defense of the bacillus is opposed to usually accepted ideas concerning the inclosure of the bacillus, its possible exclusion from the organism as a result of encapsulation, and the protection accruing to the individual by this means. The theory of Theobald Smith as to the defensive rôle of the cellular outlying breastworks in the interests of the bacillus contained within its tubercle abode, is somewhat in accord with that of Wright, although inspired by no acceptance of a special relation of opsonins or blood leukocytes to immunity. He regards the tissue reaction concerned in the process of tubercle formation as an important element in the mechanism of defense, both for the host and the parasite. Thus a quiescent focus is secured for the indefinite and undisturbed sojourn of the bacillus, but opportunities at the same time are denied for its multiplication or escape. He also advances the theory, as previously stated, that the bacilli are at times provided with a protective envelope, which he believes, in contradistinction to Wright's hypothesis, to remain intact when the opsonic power is low, and thus exert a protective influence upon the organism by preventing multiplication. An apparent immunity is supposed to exist at such a time, to be succeeded by removal of the envelope, multiplication of bacilli, and greater tuberculous activity in proportion as the opsonic power is elevated. It would seem, in the midst of conflicting views entertained by many eminent authorities, that general clinical observations should be worthy of presentation.

CHAPTER C

PERSONAL OBSERVATIONS UPON THE USE OF BACTERIAL VACCINES[1]

The published reports of Wright and his fellow-workers indicate the value of vaccine medication in localized tuberculous infections of the bones, joints, glands, and portions of the genito-urinary tract, but suggest that the results of its employment in pulmonary tuberculosis are likely to be disappointing. He recognizes elements of danger if the bacilli emulsion is administered indiscriminately to pulmonary invalids, and particularly in the presence of fever and a widely fluctuating index-curve. Under such conditions the patient is already undergoing a continuous infection from an improperly adjusted and interspersed dosage of the toxins. At such a time the employment of the vaccine only adds to the burden of the individual, and diminishes any effort on the part of the organism toward autoimmunization. This objection to the use of the vaccine in pulmonary tuberculosis, obtains in the event of an existing surplus in the blood of toxins emanating from *tuberculous foci*, and as well from centers of *secondary infection*. The

[1] A portion of this chapter was written for the annual meeting of the American Climatological Association, held in Washington, May, 1907, but was not read, owing to unavoidable absence. A supplementary report is appended, embracing the results of subsequent observation.

thought naturally arises whether the existence of a severe mixed infection in pulmonary tuberculosis materially alters the indications for tuberculin, or suggests the expediency of resorting to an autogenetic vaccine.

It is very essential to establish somewhat definitely if vaccine medication is of clinical value in pulmonary tuberculosis, and to what extent its employment should be based upon the determination of the opsonic index.

In view of the unreliability of the serum preparations sometimes employed to combat the mixed infection of pulmonary tuberculosis, and the many disadvantages attending their use, I was actuated, in the early part of 1907, to institute a clinical inquiry concerning the results possible of attainment with the bacterial vaccines. It was also my purpose to determine, if possible, the effect of the bacilli emulsion upon cases of pulmonary tuberculosis *uncomplicated* by mixed infection. It was recognized that a purely scientific investigation along these lines would involve such frequent estimates of the opsonic index as to be prohibitive of the observation of more than a few cases. In view of the supposed range of variation in the indices of many pulmonary invalids, it was felt that approximately correct conclusions from an opsonic or laboratory standpoint would demand the observations of the index once daily. I did not feel, however, that the scope of my investigation should relate merely to the recording of indices, and the assumption of an increased power of resistance in a very few closely observed cases, but rather to the *clinical study* of a comparatively large number of patients conforming to the same general class. This has necessitated the taking of the index of each patient at quite infrequent intervals. A degree of compensation for this discrepancy has been secured by the *careful selection of cases*, and the fact that the patients were kept under the closest practicable supervision in order to avoid diurnal fluctuations of the index from external causes. I beg to express my obligation to Dr. W. C. Mitchell for his careful performance of the technical portion of the work, including the determination of the opsonic indices and the preparation of the bacterial vaccines. An appreciative recognition is also accorded Dr. E. W. Emery for valuable assistance rendered in the opsonic work. In all instances the index was secured prior to the first dose, and thereafter at intervals of from ten days to a few weeks. In the beginning an effort was made to take the indices more frequently, but this practice was discontinued for several reasons. The evident futility of such spasmodic efforts to obtain an approximate estimate of the mean daily opsonic power was apparent. In view of the large number of patients undergoing vaccine treatment, frequent observation of the indices was impossible. The increased financial burden incident to their oft-repeated determination represented a factor of considerable importance. The clinical study was undertaken solely for practical purposes, and despite its deficiencies resulted in an instructive experience.

The total number of patients undergoing vaccine therapy, in the first four months of 1907 was 67, who were divided into three widely differing groups. In work of this character a proper classification of cases constitutes a feature of the utmost importance.

Group 1 comprised 42 cases of chronic pulmonary tuberculosis without symptoms referable to mixed infection. It was recognized that all patients should represent, if possible, the same general type and

stage of the disease, and conform more or less closely to a fixed régime. It seemed highly desirable that there should be eliminated all sources of confusion arising from climatic influence or change of environment. To this end patients included in this group were selected with extreme care. In view of the uncertainties attending its employment, no individual was permitted to undergo the treatment, whose general condition and previous progress had been entirely satisfactory, or who exhibited appreciable temperature elevation. On the other hand, an effort was made in the selection of cases to include only those who, *in spite of a continued residence in Colorado under appropriate conditions of daily life*, had failed to secure an entire arrest of the tuberculous process. It was believed that more definite information concerning the effect of the treatment, could be secured by limiting its application to those whose condition had been almost stationary for prolonged periods. Of all the cases comprising this group, the average period of residence in Colorado, with practically unchanged environment, was two years and eleven months, the longest being ten and one-half years and the shortest six months. A remaining activity of the tuberculous process was present in all cases, as evidenced by physical signs, cough, expectoration, and bacilli. A new method of treatment was hailed with enthusiasm by these patients as precursory of possible future recovery, thus introducing a psychic element impossible of elimination. The injections were administered at regular intervals of two weeks. This periodicity of dosage was decided upon in order to conform as far as possible to the expected expiration of the positive phase. The initial dose was usually one ten-thousandth of a milligram. Both a low and high index were considered suggestive of a small dose in the beginning.

It was noted that the initial opsonic index of several patients, upon the basis of Wright's conclusions, suggested a *non*-tuberculous condition. The variation in health is supposed to range from 0.8 to 1.2. Wright has assumed that any persisting deviation from these limits is fairly indicative of a bacterial invasion, and has regarded a normal index as suggestive of its probable exclusion. As a matter of fact, in this series many patients exhibiting a normal index were individuals displaying pronounced physical and subjective evidences of advanced tuberculous change. There was shown a *wide range* in the opsonic index, even among a group of patients especially selected with a view to securing approximate uniformity of conditions. It may be stated parenthetically that the subsequent clinical results in a few patients with high indices, indicated their favorable response to the tuberculin injections, quite as much as in others with a beginning low opsonic power. During the entire period of observation a *disparity* was noted between the *clinical* and *opsonic* findings. Many patients displaying conspicuous improvement as a result of the tuberculin injections were found to exhibit trifling variations in the opsonic index. Upon the other hand, several whose index curve was found to undergo a satisfactory elevation, nevertheless failed to respond favorably to the specific medication. The early discrepancy between the clinical and opsonic results suggested that the lack of parallelism, occasioned presumably by reason of the difficult and intricate technic was sufficient to vitiate any practical deductions based upon the observation of the index. It soon became questionable if any reliable information was furnished by the opsonic index either concerning the clinical progress or the size

and frequency of dosage. In the light of these investigations it was later decided to discontinue the study of the indices, but to pursue the inquiry along the lines of clinical observation. Although especial interest attaches to the individual cases, the clinical results may be generalized briefly. In no instance have I been able to detect permanent injury from the treatment, and in some cases conspicuous improvement. Although demonstrable progress has been established in many instances, it is probable that in some cases the psychic element has been a factor of considerable importance. It is noteworthy, however, that not infrequently depression of spirits has ensued for one or two days following the injection, several complaining of physical weakness, lassitude, and slight indisposition. Some have exhibited a rise of temperature of one or two degrees, beginning a few hours after the injection and persisting during the next day. In a few instances there has been a slight chill, followed by fever, and in two patients a severe rigor. In one case a sharp hemorrhage took place within a few hours, but ceased abruptly and was not followed by recurrences. Two others experienced a slight hemorrhage of very short duration. A number have complained of headache, this being severe in but two cases, one of which was relieved by calcium lactate. In some instances there has been temporary exacerbation of cough and expectoration.

It is apparent from these manifestations, that the agent is not always unattended by local and constitutional reaction, but the unpleasant symptoms are almost uniformly of short duration and relatively infrequent. Upon the other hand, there has been several times an admission of a material diminution of cough, and sometimes its complete cessation. The sputum has been markedly lessened in many cases. In a few instances a conspicuous diminution of bacilli has been noted several months after the inauguration of this treatment. A gain in weight has been exhibited by several patients whose previous efforts in this direction had proved unavailing. In no case has there been a loss of nutrition. A better appreciation of the character of results reasonably to be expected from time to time among cases of this character, is afforded by a brief history of a few special cases.

Case 1.—An army officer, thirty-three years of age, consulted me November 20, 1905, immediately upon arrival in Colorado, eighteen months after the development of his initial tuberculous trouble. During a six months' sojourn in New Mexico, he experienced several hemorrhages without appreciable change in the general condition. There was some temperature elevation daily, and considerable dyspnea upon exertion. There were extensive areas of active infection in each lung, moist râles being recognized upon the right side from the apex to the fourth rib, and to the lower edge of the shoulder-blade; on the left to the fifth rib, and to the very base behind. During the following year he exhibited a pronounced improvement in many respects, establishing a gain of nearly forty pounds in weight, with corresponding increase of strength and absence of fever. In January, 1907, despite an apparent amelioration of the activity of the tuberculous process, as indicated by physical signs, there remained persisting cough with copious expectoration. Perhaps the most striking feature of his case at that time was the enormous number of bacilli in the expectoration. It was determined to employ specific medication, and the bacilli emulsion was administered on January 6th. The initial dose was one ten-thou-

sandth of a milligram. No symptoms distinctly referable to this injection were displayed, although the patient volunteered the information, after a few days, that the cough and expectoration were appreciably reduced. The second dose of tuberculin was one-four-thousandth of a milligram, which, like the preceding, was unattended by pronounced symptoms, although a subsequent diminution of the expectoration was vouched for by the patient and nurse. The third injection consisted of one two-thousandth of a milligram, the dose subsequently being gradually increased until one five-hundredth of a milligram was taken at fortnightly intervals. There has taken place a material diminution of cough and expectoration, together with a gratifying increase of strength and endurance.

During the six months following this report, the improvement was continuous, the most conspicuous features being the further abatement of the cough, with entire absence of its former paroxysmal character, the comparatively scanty expectoration, the improved nutrition, and the increased general vitality.

Case 2.—A woman of twenty-five years arrived in Colorado April, 1897, several months after the development of a rapidly progressing pulmonary tuberculosis. There was a loss of twenty-six pounds in weight, with excessive cough and expectoration, acceleration of pulse, and moderate fever. She came under my observation four months later, having suffered further loss of weight and strength. There was extensive tuberculous involvement of the left lung, as evidenced by signs of consolidation, with moist râles upon easy respiration from the apex to the base in front, and to the lower angle of the scapula. In January, 1907, she had been under my care during nine and one-half years, having shown varying periods of improvement and retrogression. During the past few years, however, despite the continuous enforcement of a strict supervisory control, there had been noted but slight, if any, tendency toward improvement, although at one time there had been established a gain of thirty-two pounds in weight. During 1906 the progress of the case had been distinctly downward, the patient having lost twenty-one pounds, and exhibiting marked increase of cough and expectoration, in connection with renewed activity of the tuberculous process. Cavity formation developed in the upper portion of the left lung, with extension of the tuberculous infection to the right side from the apex to the third rib. While bacilli were exceedingly numerous, there was but slight temperature elevation. The bacilli emulsion was administered January 14th. The first injection was followed by no distinct symptoms, but a few hours after the second dose, which was one one-thousandth of a milligram, there was a sharp chill, with a later temperature elevation of 103° F., which persisted for two days. There has been no fever or other unpleasant manifestations attending succeeding doses. An improvement in the cough and expectoration, which was noted several days after the second injection, has since been maintained until both have become quite insignificant. She has gained fifteen pounds in weight, and correspondingly in strength. Examination of the chest discloses a perceptible diminution in the amount of moisture. Despite the clinical evidences of improvement, the opsonic index has shown an exceedingly slight variation, two points being the extreme in any instance, and the last index being precisely the same as that observed before the remedy was administered.

The gain thus accruing from the employment of tuberculin during a period of four months has been considerably augmented during the remainder of the year. The cough and expectoration remain very slight. The weight has further increased ten pounds, and the general strength promoted to a surprising degree. At no previous time during a residence of ten years in Colorado has the patient enjoyed an excellent appetite, with almost entire disappearance of cough and expectoration. While, generally speaking, it is well understood that no accurate conclusions are justified upon the basis of the number of bacilli, some significance, nevertheless, may be attached to the fact that they are much less numerous than formerly. (See radiograph, Fig. 54.)

Case 3.—A man, twenty-three years old, came to Colorado in October, 1905, two years and three months after the development of pulmonary tuberculosis, a considerable portion of which time had been spent in an eastern sanatorium. A progressive decline had been exhibited, with distressing cough and profuse expectoration. There was an average temperature elevation of one degree daily, the pulse ranging from 110 to 120. The temperament was nervous, and the patient was depressed and apprehensive. There was extensive tuberculous infection of both lungs. Upon the left side signs of consolidation were recognized, with loud bubbling râles from apex to base, front and back, and in the right lung, moist râles, without consolidation, from apex to base in the back. The patient remained in the recumbent position in the open air for one year and three months a trained nurse being in constant attendance. A gain of ten pounds was secured, but no perceptible improvement was noted in the condition of the lungs. In the beginning of 1907, the sputum was excessive and loaded with tubercle bacilli. The bacilli emulsion was given January 10th. A noticeable improvement has been secured, as shown by increase of strength and weight, diminution of cough and expectoration, and a pronounced change for the better in the physical signs.

During the ensuing six months the patient gained an additional fifteen pounds in weight, with corresponding improvement in the general condition. There is an almost entire absence of cough and expectoration, and a complete disappearance of tubercle bacilli. The physical signs, however, do not denote an entire arrest of the tuberculous process. Evidences of moisture are no longer recognized in the right lung, but very fine clicks are detected after a cough in the upper portion of the left back. (See Fig. 60.)

Case 4.—A woman of thirty-three consulted me February 17, 1905, two years after arrival in Colorado, and five years after the development of her pulmonary tuberculosis, during which time she had visited various health resorts. The general trend of the case having been downward from the beginning, she was advised by her medical attendant to return home. Cough was severe, expectoration copious, the temperature elevated daily, and dyspnea marked upon slight exercise. She came under my care at this time, showing extensive active tuberculous involvement of both lungs. Upon the left side there was extensive consolidation, with coarse bubbling râles to the fifth rib and to the middle of the interscapular space, and upon the right, moist râles, without consolidation, to the third rib and to the spine of the scapula. During a period of one year and eleven months up to January, 1907, she exhibited remarkable progress, gaining forty pounds in weight, with correspond-

ing improvement in strength and in the condition of the lungs. The cough and expectoration, however, remained but little affected. Tubercle bacilli, though not numerous, were recognized in every microscopic field. Injections of bacilli emulsion were commenced on January 10th. Like the preceding case, a very perceptible gain has been noted throughout the entire period of administration.

The improvement has been maintained continuously, the cough and expectoration being greatly reduced. Tubercle bacilli are absent altogether in some specimens, and in others found only after long searching. (See Fig. 83.)

Case 5.—A woman, aged twenty-three, developed tuberculosis in March, 1905, and after spending nine months in Las Vegas, New Mexico, came to Colorado with active extensive tuberculous infection of each lung. There was a loss of fifteen pounds in weight, moderate fever, weak and rapid pulse, nervous temperament, paroxysmal cough, and excessive expectoration. There were signs of consolidation in each upper lung, with moist râles on the left side, from the apex to the fourth rib and to the lower angle of the scapula; upon the right, from the apex to the third rib and to the middle of the scapula. During the summer and fall of 1906 a pronounced gain was established, the weight increasing twenty-five pounds. The upward progress apparently reached a standstill early in 1907, the physical signs being practically the same as upon arrival, and the cough and expectoration not especially diminished. The tuberculin treatment was instituted January 24th. A material subsidence of the cough and expectoration was established after a few injections, together with a distinct improvement in the physical signs, the opsonic index, however, showing scarcely any variation.

An examination of this patient, made January 6, 1908, showed no evidence of tuberculous trouble in one lung, and a very slight amount of moisture in the apex of the other. Several examinations of the sputum have failed to disclose the presence of bacilli during the past few months. (See Fig. 65.)

Case 6.—A woman of twenty-three sought climatic change in October, 1900, exhibiting active tuberculous involvement of both lungs of six months' duration. There was pronounced loss of weight and strength. The examination of the chest revealed well-defined consolidation at the right apex, with bubbling râles to the third rib and middle of the interscapular space. Upon the left side moisture was readily detected from the apex to the spine of the scapula. The progress of the case up to January, 1907, could not be regarded as satisfactory. The cough and expectoration showed but little abatement. There were daily elevations of temperature, decided impairment of appetite, and continued activity of the tuberculous process, as evidenced by numerous bacilli and persisting moisture in the finer bronchi. Throughout an entire year (1906) the patient suffered almost continuously with severe pleuritic pains in the right side, with frequent slight hemoptyses. The tuberculin was given in January, 1907, and upon the following day there was a severe rigor, followed by a sharp elevation of temperature, which persisted for two days, with noticeable aggravation of cough. In subsequent doses of one four thousandth of a milligram the patient has experienced slight malaise and indisposition for one day, without other disagreeable manifestations. A material improvement has been ex-

hibited in the general condition and physical signs, without appreciable variation in the opsonic index. At no time since beginning the administration of the vaccine, have the pleuritic pains been felt or has the slightest trace of blood appeared in the sputum.

The improvement in the physical condition has been pronounced. At present the physical signs in the left lung are entirely negative. Upon the right side, while the evidences of the early consolidation in the upper portion still persist, but an exceedingly slight amount of moisture can be recognized upon careful examination. Very fine clicks are detected in a small circumscribed area below the clavicle, and at the very apex behind. The general condition is excellent, although the cough and expectoration have not entirely disappeared and bacilli are present in small numbers.

Case 7.—A woman, twenty-four years old, arrived in Denver during the summer of 1906, after having suffered from pulmonary tuberculosis during a period of three and one-half years. There was a loss of twenty pounds in weight, moderate cough without fever, an excellent appetite and digestion. There existed marked consolidation of the left upper front to the third rib and to the middle of the scapula. Moist râles were recognized to the fourth rib in front and to the base behind. Upon the right side there were moist râles to the second rib and to the upper angle of the scapula. Bacilli were present in large numbers. During the succeeding six months not the slightest improvement was exhibited in spite of favorable surroundings and implicit obedience to detailed instructions. There resulted a loss of seven pounds in weight, a diminution of strength, increase of cough and expectoration, without fever. In view of the absence of fever and the unmistakable evidences of progressive decline, it was determined, for experimental purposes, to administer the tuberculin in spite of a relatively high opsonic power. The first dose was given on January 20th, and continued with regularity every two weeks. While no disagreeable symptoms resulted from its administration, no appreciable improvement was noted during the first six weeks. There developed subsequently a gratifying change for the better, as evidenced by great diminution of cough and expectoration, a gain in weight, and increase of strength, with lessened activity of the tuberculous process. The bacilli were decidedly less numerous in the sputum.

During the latter part of 1907 the patient evinced a remarkable improvement in all respects. The examination of the chest revealed an entire absence of moisture, while the cough and expectoration almost disappeared. (See radiograph, Fig. 64.)

Case 8.—This case is somewhat similar to the preceding in many respects. A woman of forty-six came under my observation in August, 1903, after residing in Colorado two years, and exhibiting a progressive decline from the onset of her tuberculous infection. On account of emaciation and extreme prostration, with high fever daily, diarrhea, distressing cough, and advanced tuberculous change in the lungs, the patient had been advised by her physician to return home. During the following two years she gained thirty pounds in weight and exhibited definite evidence of improvement in the general condition and in the pulmonary process. After many months' confinement in bed as a result of a series of severe hemorrhages, she lost twenty pounds in weight, and exhibited during the following year but slight recuperative power.

As a probable result of the tuberculin inoculations, the cough and expectoration materially diminished and a pronounced improvement was noted in the general strength. The bacilli were considerably less numerous than before the injections were given, but the tuberculo-opsonic index remained unchanged.

An examination of the patient upon January 5, 1908, shows an entire arrest of the tuberculous process in the right lung, with extensive fibrosis. But very fine semidry clicks are recognized after cough at the very apex of the left lung. The cough and expectoration are relatively slight, while the bacteriologic findings are absolutely negative. (See Fig. 61.)

Case 9.—A woman of twenty-seven consulted me in July, 1904, eight months after arrival in Colorado and five years following the development of her tuberculous infection. There was a loss of fifty pounds in weight, daily afternoon temperature of 101° to 102° F., marked dyspnea, and prostration. There was slight consolidation, with moist râles in the left lung from apex to base, and upon the right side to the third rib. As a result of a continuous conformity to a systematic régime, a slow but progressive improvement has taken place. In January, 1907, she had gained fifteen pounds in weight and materially in strength. The physical signs remained, however, practically unchanged. Cough was frequent and distressing, and expectoration profuse. Shortly after beginning the injections of bacilli emulsion there took place a pronounced improvement in all respects. The cough and expectoration have almost ceased. There is a gain in the general condition and a perceptible diminution in the number of bacilli.

The patient was permitted to return home during the summer of 1907, and I am informed that no retrogression has taken place. (See Fig. 68.)

Case 10.—A man, forty-one years old, came under my observation in September, 1904, nine months after the onset of pulmonary tuberculosis. There were much emaciation and physical weakness, a daily temperature elevation of two or three degrees, and distressing cough. The tuberculous process was extensive and active in each lung. Upon the right side there was consolidation with moist râles to the third rib and to the very base behind. An appreciable consolidation was recognized upon the left side, in the upper front, with slight moisture, while in the back there were coarse râles from the apex to the lower angle of scapula. Up to the fall of 1906 there was exhibited a decided improvement in all respects, the cough and expectoration disappearing altogether, the weight becoming greatly increased, with no longer evidence of active involvement upon physical examination. This case was reported a year ago as an instance of an apparent total arrest of the tuberculous process, although previously adjudged to have been utterly hopeless. After returning home and engaging again in an arduous career, he returned to Colorado in the spring of 1907, exhibiting a loss of twenty pounds in weight and renewed activity of the tuberculous process with numerous bacilli in the expectoration. After three or four doses of tuberculin were given there took place a moderate lessening of the cough and expectoration, with a corresponding diminution in the number of tubercle bacilli.

After a summer in the mountains of Colorado, during which further improvement was attained, the patient again returned to his home and resumed the duties incident to his profession. I am informed that a

further gain in weight has been secured, that the cough and expectoration are very slight, the former strength and endurance but little impaired, although a few bacilli are occasionally detected in the sputum. (See Fig. 81.)

The foregoing cases have been selected as illustrative of the beneficial influence undoubtedly exerted by the bacilli emulsion. The conclusion seems unavoidable that this agent has been responsible in large measure for the improvement noted.

Of the remaining 32 cases in this class, 15 may be said to have exhibited some favorable effect from the administration of the remedy. In 12 there was no appreciable influence properly attributable to the tuberculin. Five exhibited an increase of cough and expectoration after each injection, to such an extent that the tuberculin was suspended after three or four doses. It is noteworthy that no patient with high initial tuberculo-opsonic index, even though much in excess of normal, failed to respond favorably to the influence of the remedy. The diminution of bacilli in a number of cases is reported solely as a matter of interest, with due regard for the fact that this observation is of doubtful importance.

Group 2 consists of ten patients who had resided in Colorado for varying periods of time, but whose localized tuberculous processes suggested the advisability of this treatment. In this class are included three cases of tuberculous cervical glands, one of tuberculosis of the sacral and lumbar vertebræ, with discharging sinus, one of primary tuberculosis of the larynx, one of tuberculosis of the pharynx, one of tuberculous bronchitis, two cases of tuberculosis of the testes, and another of the kidneys.

The case of lumbar and sacral caries with discharging sinus was complicated by severe mixed infection, and, therefore, will be described under the succeeding group. One case of glandular involvement was not under observation sufficiently long to warrant the expression of a positive opinion, as to the efficacy of the treatment, but distinct improvement was noted in the second instance. The third patient with glandular tuberculosis had suffered a return of this condition after several years' disappearance of the glands, following a prolonged course of treatment with the *x*-ray. On account of an unsightly and progressively enlarging nevus over the site of the glands, presumably occasioned by the too frequent use of the *x*-ray, further recourse to this agent was impracticable upon the reappearance of the glandular enlargement. Two injections, therefore, of tuberculin were administered, and attended in each instance by a sharp local reaction, without other constitutional disturbance than physical weakness and malaise. The day following the second dose the glandular mass became increased in size, reddened, and decidedly painful. The external appearance was that of acute inflammation. In view of the pain and local discomfort, further continuance of the tuberculin was not deemed practicable. On account of the presence of the nevus, which occasioned considerable disfigurement, it was decided to resort to surgical methods for its excision and for the removal of the glandular enlargement.

The case of primary tuberculosis of the larynx has been reported elsewhere. (See p. 526.)

The patient was referred for laryngologic treatment to Dr. Levy, who rendered a guarded prognosis. The patient was kept under treat-

ment for two months, with but slight resulting improvement either in the local or general condition. He was then given the injections of bacilli emulsion during a period of two months, from which an improvement in the local condition was reported.

No conclusion of value could be drawn from the administration of the remedy to the patient with pharyngeal tuberculosis as manifestations of a general miliary involvement speedily supervened.

The case of tuberculosis of the testes, which is of great interest, has been described under Genito-urinary Complications upon p. 509.

Another case of tuberculosis of both testes has exhibited an appreciable improvement following the tuberculin injections. The tuberculous involvement upon one side was of thirteen months' duration, and upon the other of five months, the patient being a boy of nineteen without pulmonary involvement. A perceptible diminution of the discharge from each sinus has taken place, together with a reduction in the size of the tuberculous organs.

The case of tuberculosis of the kidney is also instructive. The patient, a man of about thirty-five years of age, came under my observation February 16, 1907, being referred to me by Dr. Leonard Freeman for opinion with reference to the advisability of nephrectomy. The patient had been under his care since November 1, 1906, consulting him at that time on account of a perinephritic abscess of the left side of ten days' duration following a cold. The urine was loaded with pus. The abscess was opened and found to contain a foul, thick, purulent secretion. The kidney was easily felt, and contained several small superficial abscesses, which were not incised. Subsequent examinations of the urine showed no tubercle bacilli, but numerous colon bacilli. Inoculation into the peritoneal cavity of a guinea-pig was followed by innumerable tuberculous deposits in the peritoneum and omentum. The urine was turbid, ropy, and slightly alkaline, containing a large amount of albumin. Macroscopic pus was recognized upon standing. There were many large and small round-cells, occasional normal blood-cells, and a few leukocytes. A catheterized specimen of urine from the ureter of the opposite side contained a considerable amount of albumin and a number of hyaline, granular, and epithelial casts. Catheterized specimens three weeks later showed an increased amount of albumin and casts. Early in March edema of the feet and ankles developed. The general condition was very poor, with much emaciation and weakness. The urine continued to contain a large amount of albumin and macroscopic pus, with occasional normal blood-cells. The state of the general health was not such as to suggest the expediency of immediate operation. Owing to the unquestionable tuberculous process involving one kidney, and an irritative, if not degenerative, condition in the other, it was thought best to administer the tuberculin temporarily and note results with reference to the local tuberculous process and the general condition. The bacilli emulsion was administered at frequent intervals during a period of four weeks, without the slightest evidence of resulting improvement. In spite of the desperate condition of the patient and the known serious involvement of both kidneys, I advised the performance of nephrectomy on the ground that no harm could possibly result from the removal of a large focus of tuberculous material. The operation was performed by Dr. Freeman. A fatty tumor the size of the fist was found to form a part of the kidney. The organ was disintegrated

and contained several abscesses, as well as a stone the size of the last joint of the little finger. This was soft and easily crushed. The patient did exceedingly well for some months following the removal of the kidney. He was able to walk about; the edema of the extremities largely disappeared, and the urine became much clearer, though containing some pus and albumin, occasional large and small round-cells, squamous epithelial cells, but no blood or casts. The improvement, however, was temporary, the patient succumbing several months after the operation.

Group 3 comprises an entirely different category of patients from the preceding class, as it embraces cases exhibiting not only advanced tuberculous change, but also profound constitutional disturbance resulting from secondary infection. *No patient has been included in this group concerning whom there could have been entertained any rational hope of improvement other than upon the basis of an early control of the septicemia.* Those who are familiar with the possible disadvantages attending the employment of serum preparations in this condition, and their uncertainty of action, can well understand the incentives to test the efficacy of a bacterial agent capable of wider application, especially if unattended by unfortunate sequelæ. The patients in this group number 15, the opsonic indices for the particular infection varying from 0.4 to 0.75. Upon the other hand, by a strange coincidence, the tuberculo-opsonic index was almost invariably high. The character of the infection was determined by culture methods supplementary to microscopic examination. The individual vaccines were prepared from cultures grown from the secretions of the patient to whom the agent was to be given. In 12 cases the vaccine was derived from the sputum, in 1 case from a catheterized specimen of the urine, and in 2 cases from a discharging sinus. The predominant mixed infection was in 5 instances staphylococcus aureus, in 2 cases staphylococcus aureus and albus, in 1 case staphylococcus albus, in 3 cases streptococcus, in 2 cases pneumococcus, in 1 case, colon bacillus, and in 1, micrococcus catarrhalis.

A brief generalizing statement of results is perhaps in order before submitting the detailed report of special cases. As a rule, the opsonic index to the microörganism constituting the secondary infection, did not exhibit the violent fluctuations one might naturally suppose from so severe systemic invasion. On the other hand, the tuberculo-opsonic index was higher and more constant than had been expected. In many cases this remained strangely in the vicinity of normal, in which event no effort was made to increase resistance to tuberculous infection by the use of the bacilli emulsion. In other cases, after the amelioration of the systemic infection, the patients were treated by occasional doses of the new tuberculin, but not at the same time with the other bacterial vaccines. The indices were not taken as often as could be desired, but were observed quite as frequently as was practicable under somewhat difficult circumstances. Generally speaking, the subsidence of fever and chills was accompanied by an elevation of the index for the secondary infection. Some cases, however, exhibited periods of improvement which were not associated with a corresponding change in the index. Conversely, others exhibited at times exacerbations of fever, the relation of which to the opsonic power it was difficult to determine.

In clinical observations of this character among private patients,

involving the outlay of much laborious effort in connection with the technic, and hence a considerable item of financial expenditure, it is clearly impossible to secure as much opsonic data as would appear desirable from a purely scientific standpoint. From a clinical aspect, however, the evidence was conclusive that, in some instances, much good resulted from the employment of bacterial vaccines. The unfavorable consequences were of short duration, and were incident to early injudicious dosage, although a reliant dependence at that time was placed upon the opsonic findings. Disturbing symptoms were subsequently avoided by cautious conservatism in this respect. In some instances, what developed to be a disproportionately large dose in conjunction with a low index, prolonged the so-called negative phase for a number of days, and delayed for a considerable period a subsequent elevation of the index. The imminent danger arising from such a source was later recognized, and a painstaking effort was made to regulate the size and frequency of the dose, not by the opsonic findings, but by the character of the *present* and *previous clinical manifestations.*

In view of the *desperate condition of the patients* and the dangerous possibilities attaching to the remedy, it is, perhaps, somewhat remarkable that serious results were not encountered by one previously unaccustomed to work of this nature. No patient has suffered permanent injury, although in some instances exacerbations of the constitutional symptoms have taken place. The nature and extent of the resulting disturbance have varied with the character of the bacterial infection. Thus the employment of streptococcic and pneumococcic vaccines has been followed by disagreeable symptoms oftener than injections of staphylococcic or other varieties. Out of the fifteen cases, *all but three* exhibited, following one or more injections, distinctly unfavorable symptoms, one exception being an instance of infection with micrococcus catarrhalis, another with the staphylococcus albus from a discharging sinus, and the third, a case of croupous pneumonia. In the remaining cases, varying degrees of chilliness and temperature elevation followed at least one of the injections, in some cases the disturbance partaking of a sharp rigor and resulting prostration. In the majority of instances a severe reaction has occurred but once. The unpleasant symptoms have sometimes followed the first injection, though more frequently observed in connection with subsequent doses, which were gradually increased according to the tolerance of the individual. Many patients after a single unfortunate experience, exhibited no disagreeable symptoms from repeated administrations of the vaccine. A slight elevation of temperature the day following the injection was quite generally observed. Favorable results were rarely noticed until the second or third day, and in a few cases did not persist for over one week or ten days before a tendency toward retrogression was exhibited. In such cases renewed improvement was usually noticed a few days after each succeeding dose.

The results in some cases have been uniquely satisfactory, while in others the improvement has been slow and somewhat disappointing. In a few instances, as will be noted, the gain has been quite remarkable. Of the 15 cases, 12 are reported in some detail, as well as another which was observed during the summer of 1907. Of these 13 cases, 10 exhibited very substantial improvement. The condition was so *desperate* in each instance and the improvement so *conspicuous* as to justify an assumption concerning the efficacy of the specific treatment.

In 8 of these cases there has been no retrogression during a period of one year, but one has failed to maintain the improvement previously instituted and another has died from sudden hemorrhage. In the 3 remaining cases the patients finally succumbed, although apparently responding favorably to the vaccine for brief temporary periods. In order to afford some approximate idea of the individual results obtained in this group, a brief outline of a few illustrative cases will be reported.

Case 21.—The patient was a woman, fifty years old, with pulmonary tuberculosis of eleven years' duration, the onset beginning with a severe pneumonia, which confined her to bed during nine months. There followed a persisting paroxysmal cough, with profuse purulent and, at times, fetid expectoration. Ten years ago a brisk hemorrhage took place, followed by numerous recurrences, marked loss of strength, and fifty pounds in weight. During this entire period she has developed at intervals a pronounced septic condition. In January, 1907, she presented the history of having suffered daily chills and fever during the previous two or three months, and the condition was one of extreme prostration. The examination of the chest disclosed the presence of extensive active tuberculous involvement of the right lung, from apex to base, with considerable cavity formation, together with a more recent invasion of the left lung from apex to fourth rib and to the lower angle of the scapula. Throughout these regions moist bubbling râles were recognized. Upon the right side, in addition to the massive consolidation with areas of softening and excavation, there existed at the base absolute flatness, with absence of breath- and voice-sounds, although aspiration performed not less than six or seven times was invariably attended by a negative result. Bacilli were very numerous. The mixed infection was found to be streptococcic in character. The initial streptococcic opsonic index was 0.5, and the tuberculo-opsonic index, 1.8. The first dose of streptococcic vaccine was given upon the evening of January 6th. The preparation was so standardized that one cubic centimeter represented 5,000,000 of the microörganisms. One-tenth of a cubic centimeter was administered. Upon the following day the temperature was somewhat higher than previously, and the general disturbance was more pronounced. Upon the third day the temperature dropped to normal, where it remained for nearly four weeks, during which time the patient gained materially in strength, though with continued copious expectoration. At the end of one week the streptococcic opsonic index was 0.9, showing an increase of almost one-half. A few days later the tuberculo-opsonic index was 1.9, showing a rather striking similarity to the previous observation. Upon January 26th the streptococcic opsonic index was 0.8. The vaccine was not repeated until over three weeks after the initial dose, on account of the continued improvement in the general health. After the exhibition of a slight chill with temperature elevation, the remedy was given in a somewhat larger dose than first administered. This was followed, like the preceding injection, by increased fever and prostration for one or two days, at the end of which, the temperature elevation receded and a renewed improvement took place. Since this time there have been occasional brief periods of mild temperature elevation and a few slight chills. The vaccine was given at weekly intervals, 5,000,000 of the streptococci being administered at a single injection without resulting reaction. For several months there was

but slight elevation of temperature at any portion of the day, and if present at all, only for one or two hours. The patient gained much in strength, and the cough lessened very materially. Streptococci were still present in the sputum, but the tubercle bacilli were very scanty.

In the latter part of May the patient returned to her home, and vaccine medication after a short time was discontinued. (See Fig. 70.)

Case 22.—A woman, forty-four years old, was sent to Colorado December 16, 1906, for supposed tuberculosis of the kidney, her illness being of five years' duration. The first manifestation of her present trouble consisted of severe uremic symptoms during pregnancy, necessitating the induction of premature labor. One year later, the albuminuria having persisted, another abortion was produced for the same reason. A few months after the second miscarriage one kidney was opened and drained. Since then she has had several uremic attacks. The following extract is quoted from a letter received from her attending physician at the time she came to Colorado. "Four years ago she suffered from frequent and painful urination, with the passage of large quantities of pus and blood. When I first saw her she was confined to bed very much reduced, emaciated, with irregular septic type of temperature, sweats, etc. We looked upon the case as one of tuberculous kidney. At the operation the kidney was found to be tuberculous, extensively disorganized by the prolonged suppurative process, and densely adherent to the adjacent structures. There was still a fair amount of normal kidney substance left. Her condition was so desperate that we agreed to incise the kidney and drain, believing that removal of the organ would be entirely too serious an operation for the patient in her condition at that time. The organ was opened from pole to pole down to the pelvis and thoroughly explored. No calculus could be discovered, but the condition was macroscopically one of tuberculosis. Numerous small caseous nodules were found, with large broken-down caseating areas. We had no reasonable doubt that the case was one of tuberculosis. After the operation she slowly improved, and her health up to last summer was much better than we had anticipated. During the past summer, however, she has again been losing weight, and at times has had fever. Her urine contains a varying amount of pus and blood. About six weeks ago both were present in very large quantities."

At the time the patient came under my observation there were pronounced pallor and emaciation, with considerable pain and tenderness in the region of the right kidney. Otherwise the results of palpation were negative. Micturition was very frequent, the urine being uniformly dark and smoky in appearance, acid in reaction, with specific gravity of 1020. There was a large amount of albumin. The sediment contained many pus-cells, occasional large and small round-cells, normal and abnormal blood-corpuscles. There was a pronounced bacilluria. Upon culture examination the infecting microörganism was found to be the colon bacillus. Examination made three days later was attended by similar results, save for the presence of occasional squamous epithelial cells, a few caudate cells, bloody casts, and an increase in the number of red blood-corpuscles. Exhaustive search failed to disclose the tubercle bacillus, and in response to an inquiry of her attending physician, it was found that no bacilli had ever been discovered. Subcutaneous inoculation of guinea-pigs was subsequently attended by negative results, although early peritoneal inoculation resulted in the death of one animal from colon bacil-

lus infection, pure culture being recovered from the peritoneal exudate. The patient was found to secrete a normal amount of urine as well as urea. The urine was taken from each kidney by means of the Harris segregator, and the right kidney was found to secrete only one-fifth of the amount obtained from the left. Albumin was found in each instance, though it was less in the urine obtained from the left kidney than from the right. The same was true of the blood-cells. The mixed infection was present upon both sides, though but slightly upon the left. A culture of colon bacilli was subsequently obtained from the catheterized specimen of bladder urine, and a vaccine prepared, which was so standardized that each cubic centimeter represented 25,000,000 colon bacilli. The first dose of the vaccine, consisting of one-tenth of a cubic centimeter, was administered upon January 27th, and was continued with increasing doses at weekly intervals. The urine prior to the first administration of the vaccine, was found to be extremely dark and bloody. After several days the urine was perfectly clear and transparent for the first time in many months. During the ensuing three months the urine was at no time other than of a light amber color. There resulted a progressive diminution in the amount of albumin and other abnormal constituents of the sediment. The red blood-cells became very scanty, as well as the hyaline and granular casts, with very slight evidence of bacillary infection.

During the remainder of the year the patient has continued to take the vaccine emulsion at intervals of from one to two weeks, and has shown a remarkable degree of improvement. There has been no constitutional disturbance at any time during the course of the treatment, save after an injection of 50,000,000 microörganisms, at which time there was a severe chill, with temperature elevation of one day's duration. The patient has improved wonderfully in strength, weight, and general appearance, which is now that of perfect health. There is no longer pain or discomfort in the region of the kidney or evidence of bladder irritation. A recent catheterization of the ureters shows a very satisfactory change in the urine. From the right kidney the color of the urine is pale and clear, and the amount even more than from the left, there being 30 c.c. in one-half hour. The reaction is acid, and there is but a very slight trace of albumin. In each specimen the macroscopic sediment was very slight. Upon microscopic examination occasional leukocytes and uric-acid crystals were found, but no casts and no bacilluria.

Case 23.—A man, twenty-four years of age, arrived in Colorado January 20, 1907, four years after the development of pulmonary tuberculosis. After an early gain of twenty pounds in Los Angeles and its subsequent loss upon returning home, he became the patient of Dr. Brown at Saranac, where he remained eleven weeks and gained twenty-two pounds. He later returned home and rapidly declined. Eight months before arrival in Colorado there developed a fluctuating mass in the region of the left sacro-iliac synchondrosis. This was opened shortly after and has discharged ever since. There took place a material loss of weight and strength. Before leaving home he had remained constantly in bed for seven months. A history of daily fever was obtained, the temperature ranging in the neighborhood of 102° F. There was a loss of thirty pounds in weight and obstinate diarrhea. Extensive active tuberculous involvement of both

lungs was recognized, with moderate cavity formation in the left front below the clavicle. There was a continuous purulent discharge from the sinus. The culture was found to consist of staphylococcus aureus and albus. A bacterial vaccine was made of the two microörganisms, each cubic centimeter of the vaccine representing 100,000,000 of the combined microörganisms. One-tenth of a cubic centimeter was administered upon February 5th, and was repeated every week in increasing doses until a full cubic centimeter was given. Previous to the beginnnig of the treatment the patient had complained of constant deep-seated pain in the lumbar region. The pus was thin and whitish in appearance. After the administration of the vaccine the pus exhibited a pronounced change in its gross appearance, becoming almost at once of a peculiar greenish color and thick consistency. There has been much less complaint of pain in the back, and the discharge has continued fairly profuse. Following the first few injections there was a sharp elevation of temperature for several days, and very pronounced physical prostration. At one time the pulse became extremely rapid, and a fatal termination was feared. There later developed a tolerance for the injections until there were no unpleasant symptoms following their use. The temperature has remained at normal or practically so. With the disappearance of fever the bacilli emulsion was administered. There ensued a considerable gain in strength and a beginning improvement in weight. Appetite was much better, and the troublesome diarrhea was controlled. There took place, however, no special variation in the staphylococcic index, though the tuberculo-opsonic index when last recorded was 1.6.

After exhibiting satisfactory improvement as above noted, despite an extremely desperate condition, the patient suffered a sudden change for the worse after several months' vaccine treatment, and died in the late spring of 1907. An appreciation of the advanced condition may be afforded by reference to Figs. 52, 115, and 116.

Case 24.—A woman, forty-two years old, consulted me in June, 1906, four years after the development of pulmonary tuberculosis, exhibiting a loss of twenty pounds in weight, an exceedingly rapid pulse, and dyspnea without fever. There was extensive active tuberculous infection of each lung, moist râles being recognized upon the left side from the apex to the fourth rib. There was a large cavity below the clavicle. Upon the right side moisture was present from the apex to the third rib, and in each back from the apex nearly to the base. Cough was especially severe, the expectoration copious, and bacilli were numerous. An acute appendicitis shortly developed, for which an early operation was performed. There resulted a persisting sinus and a free purulent discharge, incident to a tuberculous and staphylococcic infection. A vaccine was made from the staphylococcus albus culture, and administered weekly with injections of new tuberculin. The beginning tuberculo-opsonic index was 0.45, and the staphylococcic, 0.65. Upon the day following the first tuberculin injection, January 17th, there was marked redness of the edges of the sinus, and a greatly increased discharge, which ceased entirely upon the third day. The opening of the sinus remained closed until the succeeding injection, which was followed by a repetition of the previous increased discharge and its subsidence upon the third day. No appreciable symptoms followed immediately the injections of the staphylococcic vaccine. After three injections of each agent the sinus,

which had *persisted during a period of six months*, became permanently closed. Progressive improvement has taken place in the general condition, the cough and expectoration becoming much diminished.

The gain during the remainder of 1907 has been quite remarkable as the probable result of weekly injections of tuberculin. The patient has gained twenty-five pounds in weight and correspondingly in strength. There is a pronounced lessening in the activity of the tuberculous process, as shown by the physical signs and the exceedingly few tubercle bacilli.

Case 25.—This case is of especial interest by virtue of the detection of an enlarged mediastinal gland adjacent to the sixth dorsal vertebra upon the left side. The early history of this patient, the peculiar subjective symptoms, and characteristic physical signs resulting from bronchial occlusion, together with the laryngoscopic appearance, have been described under the subject of Glandular Tuberculosis. A photograph showing the area of percussion dulness and a skiagraph of the chest have also been exhibited. It only remains, therefore, to detail briefly the subsequent history.

The sputum was found to contain innumerable tubercle bacilli and staphylococci. A staphylococcic vaccine was prepared of such a strength that each cubic centimeter represented 60,000,000 microörganisms. The patient received four injections of the vaccine and three of the new tuberculin. An effort was made to give the tuberculin every two weeks, but this was not adhered to strictly on account of the variability of temperature, the bacilli emulsion not being administered during the time of high fever. Following each dose of the vaccine, the temperature rose several degrees and remained very high for two or three days, but the tuberculin at no time produced increased fever. One week following the first dose of tuberculin a decided improvement was noted in the amount of air passing through the left bronchus, and the respiratory sounds were distinctly heard throughout the left lung for the first time. This was also recognized by Dr. J. N. Hall, by whom the patient was examined as a matter of interest before the first injection and at the expiration of one week. The improvement in the respiration upon the left side continued marked, especially at the end of six or seven days after each injection. It was noted, however, that less air passed through the bronchial tube during the first few days after the remedy was given. There was exhibited a gain in the general strength, a diminished dyspnea, and a somewhat lessened temperature elevation. The cough and expectoration, however, were perceptibly increased. No appreciable change was noted in the number of bacilli. At the end of six weeks the further observation of the case was terminated by a sudden fatal hemorrhage. (See Fig. 55.)

Case 26.—A woman of twenty-four years came under my observation January 12, 1907, immediately upon arrival in Colorado, four months after the development of a rapidly progressing pulmonary tuberculosis. There was a loss of thirty-three pounds in weight, together with marked prostration. A fever of 104° F. daily was exhibited, with a correspondingly weak and rapid pulse. Night-sweats were severe, cough distressing, expectoration four ounces in twenty-four hours. The right lung was found diseased from apex to base. Throughout this region there was moderate consolidation, with numerous coarse and medium-sized bubbling râles, while upon the left side

moisture was detected from the apex to the third rib and to the lower angle of the scapula. Bacilli were exceedingly numerous. The mixed infection was found to be pneumococcic in character. During a period of three weeks the patient was kept constantly in bed in the open air, without the slightest evidence of resulting improvement. In fact, there was noted a further decline in strength and weight, while the fever persisted daily between 103° and 104° F. On February 5th the first dose of pneumococcic vaccine was administered, consisting of nearly 5,000,000 microörganisms. This has been repeated in increasing doses during a period of three months. No decided improvement was observed during the first six weeks, although a temporary reduction of fever was noted in some instances two or three days after the vaccine was administered. Immediately after the injections, there was often experienced a feeling of lassitude and general malaise, with occasional elevations of temperature. The fever remained, upon the whole, discouragingly high, appetite and digestion poor, with continued loss of flesh and strength. During the second six weeks there was observed a pronounced diminution of temperature, with increase of strength, revival of spirits, and gain in weight. The cough and expectoration became considerably less, and the appetite revived. The temperature rarely exceeded 100° F., and the patient was able to be out of bed in the open air. Thus far no tuberculin has been administered, as it has not been deemed wise to risk disturbing the existing improvement. For some reason the tubercle bacilli have become much less numerous.

During the ensuing six months the patient has continued to exhibit a gratifying gain in all respects, without the slightest tendency toward retrogression.

Case 27.—An interesting feature in connection with the preceding case is the fact that, in the early summer of 1907, a sister of the patient, fourteen years of age, was brought to Colorado in an almost precisely identical condition. The illness had been of one year's duration, and was attended by an acute onset following influenza. The child had exhibited high elevations of temperature daily. These were preceded, however, by moderately sharp rigors. The pulse ranged from 124 to 140, and was uniformly of poor quality. Cough was frequent, and expectoration profuse. The clinical picture was that of pronounced sepsis. Examination of the chest disclosed pronounced consolidation of the right lung from apex to base, with coarse bubbling râles throughout this region; on the left side, fine moist râles after cough from apex to base. Tubercle bacilli were numerous, and a pneumococcic culture was obtained from the sputum. Upon the score of the expense incident to the preparation of an autogenetic vaccine, and in view of the similarity of the infection, it was determined to employ the same remedy which had previously been administered to the sister. This was given at weekly intervals during a period of four months. No improvement was noted after the first five or six injections. Upon the contrary, the fever was invariably higher immediately following its administration. With a gradual recession of the fever, however, there took place a very pronounced improvement in the general condition.

During the last three or four months of 1907 there has been at no time any elevation of temperature. The child has gained eighteen pounds in weight, with a corresponding lessening in the activity of the

tuberculous process, as shown by the physical signs, with lessening of cough and expectoration.

Case 28.—A man of forty-eight years was brought to Colorado January 5, 1907. The tuberculous infection had been of six months' duration, during which time the progress of the disease had been quite rapid. A loss of forty-eight pounds had taken place, and the condition was one of utter prostration. There were frequent chills and daily elevations of temperature of 104° F., followed by drenching sweats. The mental condition was that of marked stupor, the patient failing to comprehend thoroughly the nature of direct questions. His speech was slow and hesitating, and the answers incoherent. I learned from his brother that this condition had been of several weeks' duration. The face was uniformly cyanotic, the pulse averaging from 136 to 144. Loud bubbling râles were heard upon easy respiration throughout both lungs. Bacilli were numerous, as were also the pneumococcus and staphylococcus aureus and albus. The patient was given the pneumococcic vaccine on February 5th. Three doses were administered at intervals of one week, and were followed after a few hours in each instance by a sharp rigor, increased fever, and extreme prostration. It was feared after the third injection that the patient would not be able to survive in spite of excessive stimulation and subcutaneous salt infusions. He eventually rallied, and was later given the first injection of staphylococcic vaccine; each cubic centimeter consisted of 100,000,000 microorganisms, the initial dose being one-tenth of a cubic centimeter. There was no chill or other evidence of general disturbance following this injection, although the temperature remained high for two days. Upon the third day the fever suddenly subsided, the temperature remaining in the vicinity of normal for over a week. This was accompanied by a remarkable improvement in the mental condition, the patient becoming entirely rational, the cyanotic flush disappearing from the face, and the pulse declining to the eighties. The staphylococcic vaccine was subsequently administered every ten days, together with occasional injections of a vaccine prepared from the staphylococcus albus. At no time thereafter did the copious daily sweats recur, nor did the mental condition again become clouded. There were occasional exacerbations of temperature of a few days' duration, but these were comparatively infrequent and never attained a high degree. The cough and expectoration were considerably lessened. It was apparent, however, that the tuberculous infection was too far advanced to warrant any reasonable hope of a sustained improvement, and the patient finally succumbed to general exhaustion.

Case 29.—A woman of forty-three, after a three years' illness, came to Colorado June 13, 1905, coming under my observation six months later with extensive tuberculous infection of both lungs, the left side being actively diseased throughout. There were daily fever of two or three degrees, occasional chills and night-sweats, much exhaustion, and the history of a progressive decline. She remained in the recumbent position in the open air for nearly one year without showing any satisfactory evidence of beginning improvement. In January, 1907, there had been a further decided loss of weight and strength, the temperature remaining between 102° and 103° F. daily, while the cough and expectoration were pronounced. The sputum was found to contain not only very many bacilli, but also numerous streptococci. A streptococcic vaccine was

administered February 4th and was repeated weekly without pronounced effects immediately referable to the injections, although in one or two instances there resulted moderate temperature elevation for one or two days. There developed, however, in the course of three months a considerable increase of strength and a gradual diminution of fever, with lessening of cough. The temperature remained in the neighborhood of 100° F. and rarely reached 101° F.

The improvement in the general condition thus noted was followed in the late summer by frequent exacerbations of fever, attended by marked prostration. Under these conditions the vaccine was discontinued. The patient rapidly declined, and died in the latter part of 1907.

Case 30.—A man, forty-one years old, who had previously secured a complete arrest of pulmonary tuberculosis in Colorado and was in active business, experienced, early in February, 1907, a severe rigor and speedily developed a typical croupous pneumonia. The expectoration was bloody, respiration short, jerky, and painful, and the cough most distressing. It was early apparent that the condition was to be an exceedingly desperate one. Upon the fourth day it was decided to prepare a pneumococcic vaccine from the bloody expectoration, although it was hardly thought likely that the patient would survive until the vaccine could be in readiness for administration. By the time this was prepared upon the eighth day, the crisis had apparently passed, and the general outlook was quite reassuring, suggesting the inexpediency of vaccine therapy in this case. The patient rapidly improved for four or five days, when there developed unexpectedly another severe rigor, and the temperature rose to 105° F., with recurrence of bloody expectoration, difficult and rapid respiration, and great prostration. Examination of chest disclosed an extension of the pneumonic process to the other lung, as shown by the recognition of the crepitant râle and beginning consolidation. The vaccine was immediately administered. Eight hours later the temperature was normal and remained so for about fourteen hours, when it again rose sharply, preceded by a distinct chilling. Upon the succeeding day the temperature remained constantly elevated, although the general condition was improved. A noteworthy feature at this period was the failure of the second lung to proceed to gross consolidation, as in the former instance. The temperature still remaining elevated upon the third day after the injection, another dose of the vaccine was administered. This, like the preceding, was followed by a speedy and pronounced decline of the fever, which subsequently recurred, however, upon the following day. The vaccine was repeated every third or fourth day. Several examinations of the sputum failed to disclose the presence of tubercle bacilli. After several weeks of convalescence the patient proceeded to complete recovery.

Case 31.—A man of fifty-five years came under observation March 18, 1907, six years after arrival in Colorado. The tuberculous infection developed twenty years before. Cough and expectoration had been particularly severe during this entire period. Nutrition, however, had been preserved to a remarkable extent. He had traveled extensively, visiting numerous health resorts in this country and abroad, and had been subjected for prolonged periods to a considerable variety of special treatments. Several years ago a large cavity was diagnosed in the upper portion of the right lung, and the second and third ribs were excised in the hope of producing a retraction of the chest-wall and

thus securing a partial obliteration of the cavity. The site of the incision is shown in the accompanying illustration (Fig. 169). Upon coming under my observation, the examination of the chest showed an area of consolidation in the upper portion of the right lung, with numerous fine and medium-sized moist râles from the apex to the fourth rib, with a suspicion of cavity below the clavicle. No tubercle bacilli were found in the sputum. The skiagraph disclosed an entire absence of cavity formation, but a sharply localized consolidation in the upper portion of the lung. Upon bacteriologic examination numerous colonies of micrococcus catarrhalis were found. A vaccine was prepared, and the remedy administered upon April 1st. The first dose consisted of 50,000,000 microörganisms. This has been increased until the patient received 150,000,000 at each injection. After six or eight

Fig. 169.—Cicatrix following excision of second and third ribs. (See text. Compare with radiograph, Fig. 58.)

injections a beginning improvement was noted in the amount of cough and expectoration.

The efficacy of the vaccine in this case is quite apparent from the fact that during the remainder of 1907 the patient has coughed but little, and has shown an improvement in the physical signs with disappearance of the microörganisms in the sputum.

Case 32.—Very pronounced improvement has attended the administration of a staphylococcic vaccine in a case of an apparently hopeless consumptive with tuberculous laryngitis. The patient was a young woman, twenty-four years of age, who came to Colorado March, 1907, one year after the development of her pulmonary involvement. For six weeks before arrival severe rigors were experienced daily, followed by sharp elevations of temperature. There were pronounced emaciation and prostration. Examination of the chest disclosed active tuberculous involvement in the left lung from apex to base, front and

back, with coarse bubbling râles throughout this region; on the right side, from the apex to the third rib and to the lower angle of the scapula. There was a large cavity in the right front under the clavicle. The condition was so desperate, it did not seem that the slightest encouragement could be offered. The staphylococcic vaccine was prepared and administered at weekly intervals. This was commenced in the middle of March, and after a few weeks produced a perceptible diminution in the maximum daily temperature. Following the first three or four injections the fever was increased, and the general prostration more marked. The patient, however, invariably volunteered the information four or five days after its administration that she felt better than before it was given.

In the latter part of August the temperature returned to normal, and has remained so until January 1, 1908. The patient has gained twenty pounds in weight, and examination of the chest shows but very slight moisture in the lungs. Cough and expectoration are much diminished.

Case 33.—A man of thirty-nine consulted me June 6, 1907, immediately upon arrival in Colorado, presenting the history of pulmonary tuberculosis of over one year's duration. The onset was acute, and the decline progressive. There were marked loss of weight, copious purulent expectoration, and dyspnea upon the slightest exertion. The temperature was elevated daily to the neighborhood of from 103° to 104° F., with marked acceleration of pulse. The examination of the chest disclosed the presence of active and extensive tuberculous infection, the area involved upon the right side extending from the apex to the base, with moderate consolidation throughout and a small cavity below the clavicle. Upon the left side the process was less active, though fine clicks were heard over the entire lung. During a period of two months the patient was kept in bed upon a large protected porch, a rigid enforcement of hygienic and dietetic principles being secured by the attendance of a nurse. Despite these important features of régimen, no abatement of temperature or other evidence of improvement was noted. A bacteriologic examination disclosed a pronounced streptococcic infection, and upon July 28th the bacterial vaccine was administered for the first time, the maximum temperature for that day being registered as 103° F. Upon the second day the temperature rose to 103.6° F., and on the third day was 103° F. In the course of three weeks the temperature gradually subsided to normal or thereabouts. During the ensuing five months the temperature has rarely exceeded 100° F., and has averaged in the vicinity of 99½° F. in the afternoon, the vaccine being administered at intervals of one week. The fall of temperature has been attended by corresponding evidences of constitutional improvement.

During the eight months that have elapsed since the writing of the foregoing pages extended opportunities have been offered for closer observation of the effects of the bacilli emulsion and of the homologous vaccines. These agents have been employed in a considerable number of cases since the preparation of the previous report. In using the bacilli emulsion, the same principles have been applied in the selection of cases as in the first group, the administration, as a rule, being restricted to individuals who had remained for prolonged periods in Colorado without achieving entirely satisfactory results. No permanent dis-

agreeable effects have thus far been observed from its employment among an increasing number of patients, and a general upward tendency has been exhibited in many instances. The remedy was invariably denied to incipient cases. The skiagraph (Fig. 67) illustrates the extensive pathologic changes in an individual exhibiting frequent cough and copious expectoration, with a resulting entire disappearance of tubercle bacilli. The tuberculin has been thought to be of value in several cases of tuberculous laryngitis. Improvement has also followed its application in a few additional cases of glandular tuberculosis. In my own practice, with one exception, neither the bacilli emulsion nor the autogenetic vaccines have been given more frequently than once in five days. Neither have I found it advisable in many cases to resort to progressive increase of dosage. This, perhaps, explains the absence of intolerance in my later experience, as contrasted with previous occasional manifestations of local reaction with headache, fever, malaise, and loss of appetite for a few days following the injections. In but few instances has the agent been used for patients presenting a temperature of over 100° F. It is interesting to note, however, that Krause has recently reported excellent results from the administration of tuberculin to febrile patients. He reports a permanent disappearance of the fever in all cases, and suggests, at least, a tentative administration of the remedy among a few patients who have resisted all other measures.

Recently I have had occasion to employ the tuberculin in 6 cases exhibiting persisting fever of from 102° to 103° F. daily, despite prolonged rest in bed in the open air. In 3 cases no appreciable effects were noted; in one the temperature receded within a few days to normal and has remained so for four weeks; in 2 cases the temperature has gradually receded to the neighborhood of 99° and 99.5° F.

Special bacterial vaccines have been prepared for twelve recent cases of severe mixed infection, making a total of twenty-seven patients to whom the homologous vaccines have been administered.

In the use of both the tuberculin and the bacterial vaccines among cases observed during the past few months, the dosage has been determined without reference to the opsonic index. This course has been pursued because determinations of the index sufficiently frequent to afford a basis for substantial accuracy of dosage were almost impracticable. It was found that even in carefully selected cases of pulmonary tuberculosis, the range of variation in the opsonic findings was so great as to suggest the impropriety of any arbitrary or conventional dosage without recourse to detailed clinical study. There was found to be no fixed relation between the opsonic variations and the character of the clinical manifestations. In view of the unavoidable sources for error in estimating the index, and the confusing interpretations as to the dosage, it was decided to permit the character of clinical manifestations to be the sole guide for tentative medication. The results obtained have demonstrated fully that, for practical purposes, approximate accuracy of judgment in this respect may be derived from a continuous vigilant study of the subjective and physical data. In the light of later experience it is questionable if, for general usage, the clinical method of dosage, influenced solely by the *symptomatic course*, is to be displaced by the *laboratory* method, controlled by the observation of the opsonic index. The same conclusions have been reached by

Trudeau, Baldwin, Brown, and other clinicians in various parts of the country.

It is recognized that, amid the many complicating conditions inherent to the disease and its management, many difficulties obtain in establishing the value of any therapeutic agent. It is fair to assume, however, from the accumulating mass of evidence, that the use of tuberculin and bacterial vaccines is in accord with modern theories relative to the production of artificial immunity.

As a result of my investigations, which were pursued largely along clinical lines, the following conclusions are suggested:

1. In general it may be stated that the administration of bacilli emulsion is of undoubted efficacy in *some* cases of long-standing afebrile pulmonary tuberculosis.

2. That the remedy also possesses possibilities of an injurious influence.

3. That the demonstration of an increase in cough and expectoration shortly after the injection is not necessarily indicative of its harmful effect.

4. That the *persistence* of these clinical manifestations, together with fever and greater physical weakness, despite an attempted discrimination regarding the dosage, may be accepted as definitely conclusive of its detrimental action.

5. That, in the event of severe mixed infection with considerable temperature elevation, it is highly inexpedient, as a rule, to attempt the production of an increased tuberculo-opsonic power until after the amelioration of the secondary infection.

6. That the administration of bacterial vaccines derived from the secretions of the patient is often indicated in the presence of the constitutional and bacteriologic evidences of mixed infection.

7. That, in view of the numerous possibilities of error incident to the opsonic findings, discriminating *clinical study* is absolutely essential in the determination of the size and frequency of the dosage.

8. That despite the uncertainties of action of autogenetic vaccines, a justification for their employment is found in the *desperate* character of the cases to which they are given, and their superiority over the various sera formerly used.

9. That in some cases bacterial vaccines present possibilities of benefit far beyond the limits of former therapeutic efforts.

10. That the rôle of the opsonic index in vaccine therapy still remains an experimental study, to be approached with the utmost conservatism, but in a spirit of receptive inquiry. The data thus far presented suggest that this feature should remain for the present *sub judice*.

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